DOCUMENT RESUME

ED 287 677 SE 048 631

TITLE	Guidelines for Program Development--Science.
INSTITUTION	Kansas State Dept. of Education, Topeka.
PUB DATE	Oct 84
NOTE	66p.
PUB TYPE	Guides - Classroom Use - Guides (For Teachers) (052)
EDRS PRICE	MF01/PC03 Plus Postage.
DESCRIPTORS	*Curriculum Development; Curriculum Evaluation; Elementary School Science; Elementary Secondary Education; Problem Solving; Science and Society; *Science Curriculum; Science Education; Science Instruction; Science Teachers; Secondary School Science; State Curriculum Guides; Student Evaluation; Theory Practice Relationship
IDENTIFIERS	*Kansas

ABSTRACT

This guide is designed to provide a rationale and structure which can enable educational planners and decision makers in Kansas to develop and select science curricula. The content of the publication is intended to be used by administrators in charge of curriculum, departmental and district science chairpersons, and all teachers, citizens and students interested in science curriculum planning. The guide is K-12 in scope and it is suggested that school districts in Kansas use the objectives presented in the guide as criteria for evaluation. Included in the document are sections on: (1) a model for science education; (2) learning processes; (3) psychomotor skills; (4) a learning process model of instruction, (5) attitudes and values; (6) program outcome objectives; and (7) overall science objectives and skills. The appendices contain references and suggested readings for the classroom teachers, classroom hints for the teacher, and information on what research says about teaching science. (TW)

****
* Reproductions supplied by EDRS are the best that can be made *
* from the original document. *
****

"PERMISSION TO REPRODUCE THIS MATERIAL HAS BEEN GRANTED BY

Ramona J. Anahuta

TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)."

U.S. DEPARTMENT OF EDUCATION
Office of Educational Research and Improvement
EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)

X This document has been reproduced as received from the person or organization originating it.

☐ Minor changes have been made to improve reproduction quality.

• Points of view or opinions stated in this document do not necessarily represent official OERI position or policy.

ED287677

SE 049 631

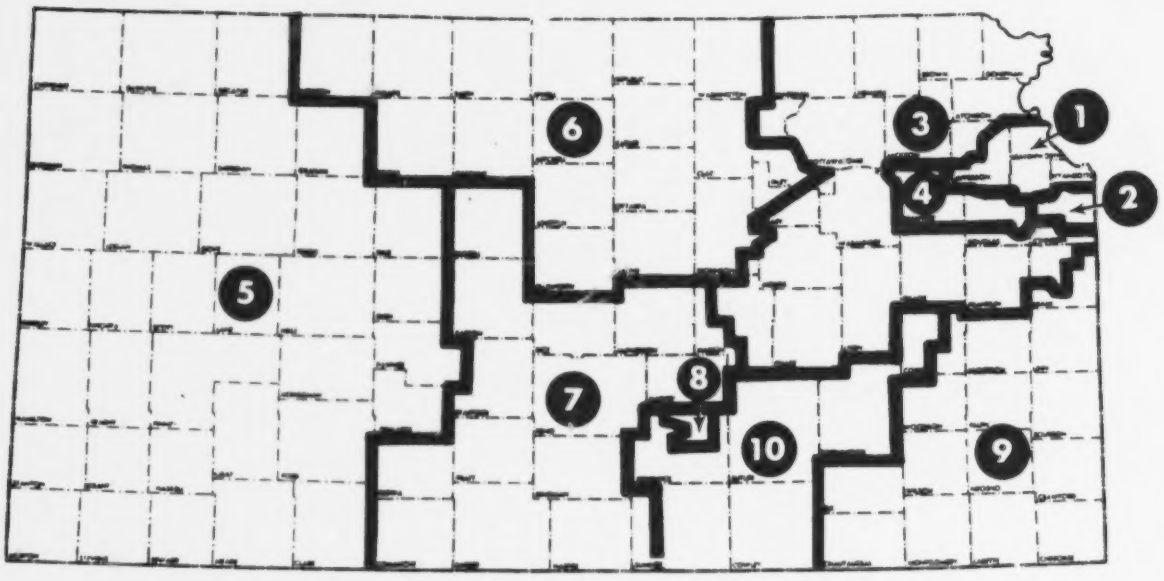
Guidelines for Program Development -- Science

Kansas State Department of Education
Kansas State Education Building
120 East 10th Street Topeka, Kansas 66612

An Equal Employment/Educational Opportunity Agency

BEST COPY AVAILABLE

KANSAS STATE BOARD OF EDUCATION DISTRICTS



STATE BOARD OF EDUCATION

Kay Groneman
District 1

Kathleen White
District 2

Dale Louis Carey
District 3

Connie Hubbell
District 4

Sheila Frahm
District 5

Bill Musick, Vice-Chairman
District 6

Theodore R. Von Fange, Ed.D.
District 7

Evelyn Whitcomb
District 8

Robert J. Clemons, Chairman
District 9

Marion (Mick) Stevens
District 10

KANSAS STATE DEPARTMENT OF EDUCATION

Harold Blackburn, Commissioner

Division of Education Services
Sharon E. Freden, Assistant Commissioner

Educational Assistance Section
Tom Walsh, Director
Ramona J. Anshutz
Education Program Specialist
Science

Guide Prepared Under the Direction
of
Ramona J. Anshutz
Science Specialist

October, 1984

FOREWORD

Thank you for your interest in this curriculum guide. It is the hope of the Kansas State Department of Education that you will find the information helpful. The staff members who have prepared these documents have spent many long hours researching and reflecting on the content of the guide. Particularly important were the contributions made to the guide by teachers and other practitioners in the field.

While we are proud of the final product there are several precautions that should be observed in using this material. Every community, school and classroom is different. There are many concepts that must be taught at each grade level and in various content areas. Educators have the responsibility for determining student needs, providing programs to meet those needs and measuring educational outcomes. The process of planning and implementing an instructional program should involve educators and others who are also responsible for student learning outcomes.

The guide can be a part of the instructional process. This process begins with a needs assessment, identifying appropriate goals and objectives to meet these needs, developing a program of instruction, and evaluating progress. Many of the ideas or suggestions found in this guide may be applicable to your situation.

Educational Assistance Section personnel are available to you for help. If your staff would like to visit with Kansas State Department of Education staff please contact us (913/296-4946). We share your goal of developing curricular and instructional programs that will best serve the needs of the student.

Harold L. Blackburn
Commissioner of Education

ACKNOWLEDGEMENTS

SCIENCE COMMITTEE

Serving as members of the Science Advisory Committee for the development of the state science guidelines booklet were science educators, classroom teachers, administrators, and scientists. Individually and collectively their counsel, comments, and constructive criticism proved to be a sound basis for the development of the guide.

George Anshutz, Superintendent, Wabaunsee East USD 330, Box 158, Eskridge, Kansas 66423

Bill Claflin, Fort Hays State University, Hays, Kansas 67601

Frank Colaw, Superintendent, Osage City USD 420, 5th and California, Osage City, Kansas 66523

Larry Enochs, Department of Education, Kansas State University, Manhattan, Kansas 66506

Steve McCollum, Winfield High School, 300 Viking Boulevard, Winfield, Kansas 67156

Charlotte McDonald, 15292 Newton, Stanley, Kansas 66223

Sue Miller, USD 457, 805 West Fair, Garden City, Kansas 67846

Dan Mueller, Director of Curriculum, USD 244, 219 North 3rd Street, Burlington, Kansas 66839

Walter Smith, University of Kansas, 205 Bailey Hall, Lawrence, Kansas 66045

Michael Spurgeon, Louisburg USD 416, Box 911, Louisburg, Kansas 66053

Sam Wine, Box 254, Madison, Kansas 66860

Dr. Ramona J. Anshutz, Education Program Specialist, Science and Mathematics, Educational Assistance Section, Division of Education Services, Kansas State Department of Education, 120 East 10th Street, Topeka, Kansas 66612

SCIENCE GUIDE
FIRST REVISION COMMITTEE

William B. Allen, R.R., Denton, Kansas 66017

Pris Callison, 327 S.W. Quinton Avenue, Topeka, Kansas 66606

Bill Claflin, 200 West 5th, Hays, Kansas 67601

Mary Ellis, 5718 Outlook, Apt. 305, Mission, Kansas 66202

Dudley Fryman, R.R. #2, Garden City, Kansas 67846

Neil Miller, 4702 Sullivan Road, Wichita, Kansas 67204

Don Nigus, Box 218, Bendena, Kansas 66008

Grant Rhoades, 218 E. Bellvue, Garden City, Kansas 67846

Janet J. Woerner, 8439 Kessler, Overland Park, Kansas 66212

Margaret L. Young, 4505 W. 74th Place, Prairie Village, Kansas 66208

Dr. Ramona J. Anshutz, Education Program Specialist, Science and Mathematics, Educational Assistance Section, Division of Education Services, Kansas State Department of Education, 120 East 10th Street, Topeka, Kansas 66612

SCIENCE GUIDE
SECOND REVISION COMMITTEE

George Anshutz, Superintendent, Wabaunsee East USD 330, Box 158, Eskridge, Kansas 66423

Bill Claflin, Fort Hays State University, Hays, Kansas 67601

Frank Colaw, Superintendent, Osage City USD 420, 5th and California, Osage City, Kansas 66523

Larry Enochs, Department of Education, Kansas State University, Manhattan, Kansas 66506

Steve McCollum, Winfield High School, 300 Viking Boulevard, Winfield, Kansas 67156

Charlotte McDonald, 15292 Newton, Stanley, Kansas 66223

Sue Miller, USD 457, 805 West Fair, Garden City, Kansas 67846

Dan Mueller, Director of Curriculum, USD 244, 219 North 3rd Street, Burlington, Kansas 66839

Walter Smith, University of Kansas, 205 Bailey Hall, Lawrence, Kansas 66045

Michael Spurgeon, Louisburg USD 416, Box 911, Louisburg, Kansas 66053

Sam Wine, Box 254, Madison, Kansas 66860

Dr. Ramona J. Anshutz, Education Program Specialist, Science and Mathematics, Educational Assistance Section, Division of Education Services, Kansas State Department of Education, 120 East 10th Street, Topeka, Kansas 66612

TABLE OF CONTENTS

Title Page i
Foreword ii
Acknowledgements iii
Science Committees iii
Introduction 1
Purpose 1
Goal 1
Model for Science Education 1
Psychological Basis 1
Learning Processes 3
Psychomotor Skills 3
Learning Process Model of Instruction 3
Attitudes and Values 5
Organization of Guide 5
Program Outcome Objectives 7
Overall Science Objectives and Skills 7
Grade Level Objectives and Skills 9
Belleville Curriculum Guide 29
Appendix
References Used in Preparing this Guide 73
Suggested Reading for the Classroom Teacher 75
Implementation Schedule 77
Attitudes 79
Classroom Hints for the Teacher 81
What Research Says About "Educating Americans for the 21st Century" 83

INTRODUCTION

PURPOSE

This guide is designed to provide a rationale and structure which will enable educational planners and decision makers to develop and select science curricula. The content within this publication is intended for use by administrators in charge of curriculum, departmental and district science chairpersons, and all teachers, citizens and students interested in science curriculum planning. The theories, models and structures provided are to be used as guides for developing programs which meet the specific needs and situations of individual districts. This guide is a K-12 science program. It is hoped that as districts across the state of Kansas review and develop their science curriculum, that the objectives within this guide will be used as criteria for evaluation.

GOAL

THE GOAL OF SCIENCE EDUCATION IN KANSAS IS TO DEVELOP A SCIENTIFICALLY LITERATE CITIZENRY.

Scientific literacy is subdivided into the cognitive domain, affective domain and the psychomotor domain. The cognitive domain can be further subdivided into knowledge about science, which includes the nature of science, concepts within science and the interaction between science and society, and the processes of science. The affective domain includes the values and attitudes within science, and the interest and motivation to study science. The psychomotor domain encompasses the manipulative skills necessary to operate as a scientist. It is the primary goal of science education to maximize the attainment of the objectives within each of the areas which lead to the development of a scientifically literate individual.

MODEL FOR SCIENCE EDUCATION

A rocket is used as the symbol for scientific literacy. Like a rocket, science can be envisioned as a vehicle to explore the frontiers of knowledge (Figure 1). The process skills of the scientist open a path to new realms of knowledge. The psychomotor skills, attitudes and concepts, are necessary to guide the scientifically literate person in the quest for a better understanding of himself and the world around him. It is the inherent force of problem solving that constitutes the thrust to search through irrelevant information and seek out possible solutions to meaningful questions.

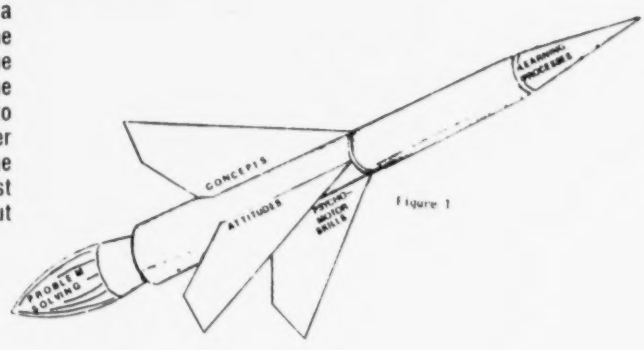


Figure 1

PSYCHOLOGICAL BASIS

The organization of the concepts and processes of science, as presented in this guide, is based upon developmental learning theories.

The three developmental levels of concern are preoperational, concrete operational and formal operational.

This guide has been developed in an effort to structure the curriculum which will allow for involvement of all learners in activities which are directed toward enabling the maximum level of learning.

Emphasis should be placed upon concrete experiences in the primary grades. In the intermediate grades, increasing emphasis is placed on experiences which involve abstract thinking and rely less on concrete experiences. Students in the Junior High/Middle School years should be involved in activities which encourage the use of thought at the formal operational level. In the High School science classes, abstract concepts should be developed through the use of all of the process skills. The student should, upon completion of the K-12 program, be operating as a scientifically literate person, capable of independently seeking out new relationships and forming new concepts.

LEARNING PROCESS

The learning processes identify those necessary skills utilized in a logical approach to discovering knowledge. They enable students to achieve the skills necessary to survive in a technologically advanced society. The inclusion of the learning processes as the organizational framework is based upon the recognition of the dynamic nature of science. The realization of a scientifically literate society is dependent on the participation of all individuals in the process of science.

The learning processes can be subdivided into two phases. The basic skills phase deals with the gathering, organizing and reporting of relevant information. The integrated skills phase deals with the search for a discovery of relationships within the data. There is an ordered structure within the learning processes which results from the degree to which manipulations are performed with the observable data. Within the learner there also exists a developmental sequence which at different stages enables the mastery of specific skills.

Figure 2 incorporates these two dimensions into a model of instruction for the process skills. The verticle axis represents the K-12 sequence and the horizontal axis represents the sequence of learning processes. Region #1 (*) indicates the years at which specific skills are introduced. Throughout the years following the introduction of a particular skill, it is refined as indicated by Region #2 (*). Region #3 (*) of the model indicates the time zone in which it is inappropriate to deal with certain skills; because of the incompatability of the skill with the learner characteristics. The model of the learning process displays the relationship between the learner and the skills. Through implementation of the model, the learner at all stages of development will be refining and developing an ever increasingly sophisticated methodology for problem solving.

PSYCHOMOTOR SKILLS

Psychomotor skills include large and small muscle movement and eye-hand coordination. The development of manual dexterity and physical awareness are important goals of science education. In order to make observations, gather data and perform experiements, a student needs to become physically involved with the environment.

Scientific activities often involve very precise measurements and complicated manipulative procedures. To obtain useable data from which to build inferences, the physical component must be as exacting as possible.

In order to ensure safety when working with dangerous chemicals and equipment, the student must refine his fine motor movements. It is necessary to include goals, related to the development of psychomotor skills, thus minimizing the risks of injury when performing experiments. Even though science is largely thought of as a cognitive exercise, without direct physical involvement with the environment, the empirical data base for scientific study is unattainable.

LEARNING PROCESS
MODEL OF INSTRUCTION

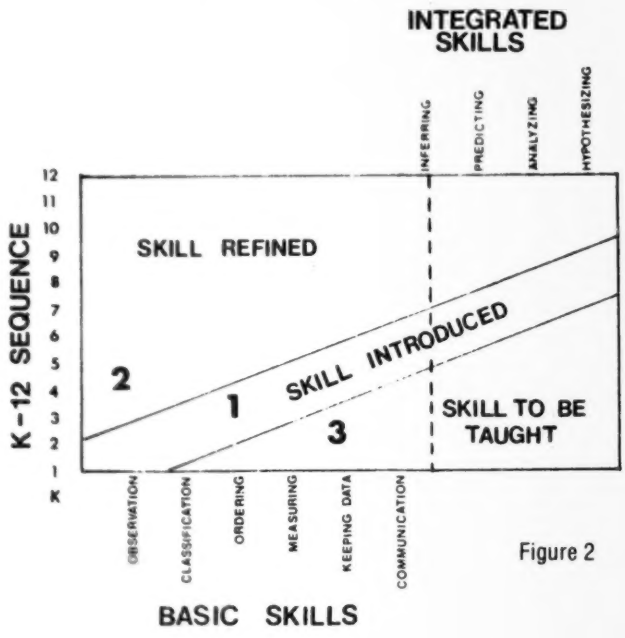


Figure 2

ATITUDES AND VALUES

Attitudes and values determine the extent to which the processes of science are put to productive use. Only with a constructive attitude is the scientifically literate person able to explore the frontiers of knowledge. When misplaced values such as personal prejudice and dishonesty are represented, the scientific quest for truth is misguided and the ultimate destiny is not achieved.

There needs to be curriculum directed toward the development of positive attitudes toward science. Improved attitudes lead to higher motivation and involvement in the enterprise. Emphasis needs to be placed on the development of a scientific values system in order to ensure the success of scientific endeavors.

ORGANIZATION OF THE GUIDE

The Kansas Science Education Curriculum Guide is divided into three sections. The introduction has been used to describe the purpose, philosophy and rationale for science education. The second section presents the grade level expectations. The purpose of this section is to provide the curriculum planner with a scope and sequence model to guide in the development of a science program. Included in this section are exit objectives by grade level and example activities for each grade level which are appropriate for the stated objectives. The exit objectives delineate expectations for a student who has successfully completed that grade level. The grade level objectives are meant to provide a general framework for a science curriculum. They are in no way intended to be restrictive in nature. They are not a total curriculum in themselves. These objectives are presented to emphasize important concepts, skills and attitudes appropriate for a specific grade level.

Supportive information is presented in the appendix. Additional supplemental information may be added at future dates. Included in the appendix will be a guide developed by the Belleville public schools K-12 (using the state guide as a model for development), relevant articles, a glossary, and a bibliography.

This guide is to be a reference. Additional supportive information and input will be included whenever the need arises. This guide should be used by curriculum planners as they develop new science programs and as they evaluate those in practice. Hopefully, through continued use of this guide, a gradual consistency and continuity will emerge in the K-12 science programs across the state of Kansas.

Scientific content, comprised of facts, concepts and generalizations, infuses the total K-12 science curriculum. Content is the end product of the learning processes. Emphasis has been placed on the development and refinement of the learning processes because it is through utilization of the processes that the content of science is obtained, organized and confirmed. To be fully cognizant of science, the learner must be aware of the nature and processes of science. To be merely aware of the end products of science does not signify the realization of scientific literacy.

It is assumed that complete understanding of scientific concepts required reasoning patterns at a higher level of learning. It is expected that only introduction and partial progress can be made from kindergarten through junior high. Therefore, the central task would be to provide concrete experiences that become the foundation for concept formation in higher level science. Facts and concepts should be incorporated as they are encountered during the natural progression through the learning processes. In order to further enhance the understanding of the scientific enterprise, additional focus should be placed on the following clusters:

I Personal Needs --
to use the outcomes of science instruction for improving one's personal life and for coping with an increasingly technological world,

II Societal Issues --
to use the outcomes of science instruction to deal responsibility with science-related societal issues,

III Fundamental Knowledge --
to use the outcomes of science instruction for the pursuit of knowledge for its own sake and for professional training, and

IV Careers --
to use the outcomes of science instruction for awareness of a variety of science and technology-related jobs.

PROGRAM OUTCOME OBJECTIVES

The student will be able to:

1. Value science as a way of learning and communicating about self, others and the environment.
2. Use scientific problem-solving and learning processes.
3. Demonstrate knowledge of representative scientific theories, assumptions, principles, laws, facts and their cultural and historical contexts.
4. Demonstrate the use of scientific knowledge and processes to clarify his values, examine issues, solve problems (both personal & social) and to satisfy personal curiosity.
5. Relate science learning to the planning and fulfilling of personal, social and career roles.
6. Use the appropriate language, tools and operations of science.
7. Value science for its contribution to continuing personal experiences.
8. Discover and learn the knowledge, skills, attitudes and values necessary to carry out career decisions.

OVERALL SCIENCE OBJECTIVES AND SKILLS

I. Stimulate the natural curiosity of the student in the phenomenon of science.

II. Develop the scientific skills of science through:

- A. *Observing* - Identifying and describing properties of objects through the use of the senses - size, shape, color, texture, sight, smell, taste, hearing.
- B. *Classifying* - Sorting and arranging according to common properties and characteristics.
- C. *Ordering* - Arranging in series of sequence. (Example - color light to dark, length of dowel sticks larger to smaller)
- D. *Keeping Data* - Recording observations accurately through the use of charts, graphs, logs, and journals.
- E. *Measuring* - Assigning numbers according to rules. (Example - time and temperature)
- F. *Communicating* - Describing orally or in written form by drawing and diagramming an object or idea for the understanding of others. (Example - graphing)
- G. *Inferring* - Making a judgment or relationship of collected data.
- H. *Predicting* - Estimating the future events using data collected.
- I. *Analyzing* - Systematically searching for relationships among the data.
- J. *Hypothesizing* - Making a testable prediction.
- K. *Experimenting* - Recognizing an appropriate sequence related to the laboratory investigation anywhere the investigation would take place.
- L. *Interpreting Data* - Describing information found in data.

III. Create an awareness of *total environment* and how the environment affects the student.

IV. Provide basic concepts in science.

V. Provide hands-on experiences in working with materials.

VI. Implement practical application.

GRADE LEVEL OBJECTIVES AND SKILLS

KINDERGARTEN

GENERAL CHARACTERISTICS OF STUDENT:

MENTAL	*PHYSICAL*
Imaginative Short Attention Span Self-centered Little Control of Emotions Honest Curious	Constantly Active (Large muscle movement more developed than small.)

OBJECTIVE: The Kindergarten science program will enable student to acquire and refine the following:

COGNITIVE DOMAIN		**AFFECTIVE DOMAIN**	**PSYCHOMOTOR DOMAIN**
CONCEPTS	*LEARNING PROCESSES*	*ATTITUDES*	*MANIPULATIVE SKILL*
CENTRAL FOCUS Provide concrete experiences which become the foundation for concept formation in higher level science *	*CENTRAL FOCUS* Introduce: *OBSERVATION — IDENTIFYING AND ACQUIRING INFORMATION THROUGH THE FIVE SENSES*	*CENTRAL FOCUS* Provide experience for growth of: Curiosity Honesty Imagination Concern/Care Self-confidence Persistence	*CENTRAL FOCUS* Skills which would enable students to handle materials appropriate for large muscle development, i.e., magnifying lens

* *Rationale for concept statement: Complete understanding of scientific concepts requires reasoning patterns at an advanced level of learning.*

EXIT OBJECTIVES:

The student will be able to:

COGNITIVE DOMAIN	**AFFECTIVE DOMAIN**	**PSYCHOMOTOR DOMAIN**
Observe using the five senses	Demonstrate the growth of attitudes, i.e., curiosity, honesty, imagination, persistence and concern/care	Handle materials appropriate for level physical development

EXAMPLE:

Activities using the senses -- emphasis placed on exploring differences in size, shape, color, texture, etc.

Materials which could be used: leaves, rocks, shells, bottle caps, basic geometric shapes and any other appropriate materials

FIRST GRADE

GENERAL CHARACTERISTICS OF STUDENT:

MENTAL	*PHYSICAL*
Imaginative — Dramatic	Large muscles more highly developed than small ones
Short Attention Span	
Individualistic	
Honest	Beginning to refine small muscle movement involving eye-hand coordination
Curious	
Emotions Not Too Well Controlled	

OBJECTIVE: The First Grade science program will enable students to acquire and refine the following:

COGNITIVE DOMAIN		**AFFECTIVE DOMAIN**	**PSYCHOMOTOR DOMAIN**
CONCEPTS	*LEARNING PROCESSES*	*ATTITUDES*	*MANIPULATIVE SKILL*
CENTRAL FOCUS Provide concrete experiences which become the foundation for concept formation in higher level science *	*CENTRAL FOCUS* Emphasize: Observation Introduce: *CLASSIFICATION — SORTING INTO GROUPS ACCORDING TO PROPERTIES* **	*CENTRAL FOCUS* Provide experience for growth of: Curiosity Honesty Imagination Concern/Care Self-confidence Persistence	*CENTRAL FOCUS* Skills which would enable students to handle materials appropriate for large muscle development, i.e., magnifying lens, eye dropper, and/or other appropriate materials

* *Rationale for concept statement: Complete understanding of scientific concepts requires reasoning patterns at an advanced level of learning.*

** *Observable Characteristics*

EXIT OBJECTIVES:

The student will be able to:

COGNITIVE DOMAIN	**AFFECTIVE DOMAIN**	**PSYCHOMOTOR DOMAIN**
Sort into groups according to observable properties	Demonstrate the growth of attitudes, i.e., curiosity, honesty imagination, persistence and concern/care	Handle materials appropriate for physical development, i.e., magnifying lens, eye dropper, etc.

EXAMPLE:

Provide experiences in activities whereby the students can disseminate, sort and arrange likenesses and differences according to common properties, living and non-living materials.

Materials which could be used: Anything living or non-living that is appropriate.

SECOND GRADE

GENERAL CHARACTERISTICS OF STUDENT:

MENTAL	*PHYSICAL*
Short attention span Desires to please and excel Urge for leadership and responsibility Wants independence but seeks security	Very active Big muscle movement still more developed than small muscle Eye-hand coordination continues to be refined

OBJECTIVE: The Second Grade science program will enable student to acquire and refine the following:

COGNITIVE DOMAIN		**AFFECTIVE DOMAIN**	**PSYCHOMOTOR DOMAIN**
CONCEPTS	*LEARNING PROCESSES*	*ATTITUDES*	*MANIPULATIVE SKILL*
CENTRAL FOCUS Provide concrete experiences which become the foundation for concept formation in higher level science *	*CENTRAL FOCUS* Emphasize: Observation Classification Introduce: *ORDERING — RANKING OBJECTS ACCORDING TO COMMON PROPERTIES* **	*CENTRAL FOCUS* Provide experience for growth of: Curiosity Honesty Imagination Concern/Care Self-confidence Persistence	*CENTRAL FOCUS* Skills which would enable students to handle materials appropriate for large muscle development and eye-hand coordination, i.e., using thermometers, measuring devices, timing devices and other appropriate materials

* *Rationale for concept statement: Complete understanding of scientific concepts requires reasoning patterns at an advanced level of learning.*

** *Observable Characteristics*

EXIT OBJECTIVES:

The student will be able to:

COGNITIVE DOMAIN	**AFFECTIVE DOMAIN**	**PSYCHOMOTOR DOMAIN**
Rank objects according to common properties	Demonstrate the growth of attitudes, i.e., curiosity, honesty, imagination, persistence, and concern/care	Handle materials appropriate for physical development

EXAMPLE:

Provide experiences whereby the student can:

1) *Serial order (i.e., smallest to largest, tallest to shortest, lightest to heaviest, etc.)*
2) *Measure temperature daily using thermometer*
3) *Set time using wall clock to measure time*

Materials which can be used: sand, seasonal things, living organisms, etc.

THIRD GRADE

GENERAL CHARACTERISTICS OF STUDENT:

MENTAL

Short attention span
Desires to assume responsibility but lacks skill with which to do it
Wants praise and encouragement from adults
Aware of individual differences
Curious
Imaginative
Sensitive
Annoyed by conformity

PHYSICAL

Large muscles more developed than smaller ones
Active
Energetic
Eye-hand coordination continues to be refined

OBJECTIVE: The Third Grade science program will enable student to acquire and refine the following:

COGNITIVE DOMAIN

CONCEPTS

CENTRAL FOCUS
Provide concrete experiences which become the foundation for concept formation in higher level science *

LEARNING PROCESSES

CENTRAL FOCUS
Emphasize:
Observation
Classification
Ordering
Introduce:
KEEPING DATA — REPRESENTING AND PRESERVING DATA IN AN ORGANIZED SYMBOLIC FORM

AFFECTIVE DOMAIN

ATTITUDES

CENTRAL FOCUS
Provide experience for growth of:
Curiosity
Honesty
Imagination
Concern/Care
Self-confidence
Persistence

PSYCHOMOTOR DOMAIN

MANIPULATIVE SKILL

CENTRAL FOCUS
Skills which would enable students to handle materials appropriate for large muscle development and eye-hand coordination, i.e., using simple balances, thermometers, metric equipment, tape recorders, timing devices, magnets, and living things

* *Rationale for concept statement: Complete understanding of scientific concepts requires reasoning patterns at an advanced level of learning.*

EXIT OBJECTIVES:

The student will be able to:

COGNITIVE DOMAIN

Keep data in a symbolic form

AFFECTIVE DOMAIN

Demonstrate the growth of attitudes, i.e., curiosity, honesty, imagination, persistence and concern/care

PSYCHOMOTOR DOMAIN

Handle materials appropriate for physical development

EXAMPLE:

Constructing a histogram using size of oranges, buttons, birthdays, raisins in cookies, eye color, etc.

Materials which can be used: oranges, buttons, shells, rocks, cookies, etc.

FOURTH GRADE

GENERAL CHARACTERISTICS OF STUDENT:

MENTAL

Capable of prolonged interest
May go ahead on his own
Wants to do things well
Gets discouraged under pressure
Argues over fairness
Wants group approval
Can be aggressive — needs responsibility

PHYSICAL

Very distinctive individual physical differences
Small motor development is getting better
Eye-hand coordination continues to be refined
Often gets overactive, hurried or careless, may have accidents
Prefer all one sex grouping

OBJECTIVE: The Fourth Grade science program will enable students to acquire and refine the following:

COGNITIVE DOMAIN

CONCEPTS

CENTRAL FOCUS
Begin concept formation of:
Interaction
Variable
Systems/subsystems
Environment
Energy
Matter
Space/time
Cause/effect *
Additional Focus:
1) leaders in science throughout history,
2) contemporary social issues involving technological development, and
3) the nature of scientific enterprise

LEARNING PROCESSES

CENTRAL FOCUS
Emphasize:
Observation
Classification
Ordering
Introduce:
MEASURING — A PROCEDURE FOR COMPARING AN OBJECT BY ASSIGNING A VALUE ASSOCIATED WITH A STANDARD UNIT **

KEEPING DATA — PERFORM MEANINGFUL MANIPULATIONS IN ORDER TO MAKE DATA EASIER TO UNDERSTAND

COMMUNICATING — TO EXCHANGE INFORMATION VERBALLY AND/OR NON-VERBALLY

AFFECTIVE DOMAIN

ATTITUDES

CENTRAL FOCUS
Provide experience for growth of:
Curiosity
Honesty
Imagination
Concern/care
Self-confidence
Persistence

PSYCHOMOTOR DOMAIN

MANIPULATIVE SKILL

CENTRAL FOCUS
Skills which would enable students to handle materials appropriate for level of development, i.e., using simple machines, living things, metric measurement devices, and timing devices
Simple balance
Constructing charts

* *Rationale for concept statement: Complete understanding of scientific concepts requires reasoning patterns at an advanced level of learning.*

** *Universally accepted quantity*

EXIT OBJECTIVES:

The student will be able to:

COGNITIVE DOMAIN

1) measure two dimensionally
2) use charts to make data easier to understand
3) communicate information verbally and/or non-verbally

AFFECTIVE DOMAIN

Demonstrate the growth of attitudes, i.e., curiosity, honesty, imagination, persistence and concern/care

PSYCHOMOTOR DOMAIN

Handle materials appropriate for physical development

EXAMPLE:

Chart the growth of plants and/or animals, types of rocks, weather events, etc.

Materials which could be used: simple machines, living things, metric measurement devices, timing devices, simple balances, charts, etc.

FIFTH GRADE

GENERAL CHARACTERISTICS OF STUDENT:

MENTAL

Willingness to work to receive recognition
Desires to become more independent
Willing to help others
Can check own progress
Group loyalty important
May go to great lengths to gain approval and respect of members of their own group
Enjoys group participation

PHYSICAL

Stronger muscles and longer bones
Increased resistance to disease
Girls are starting to mature
Eye-hand coordination refined

OBJECTIVE: The Fifth Grade science program will enable students to acquire and refine the following:

COGNITIVE DOMAIN

CONCEPTS

CENTRAL FOCUS
Begin concept formation of:
Interaction
Variable
Systems/subsystems
Environment
Energy
Matter
Space/time
Cause/effect
Additional Focus:
1) leaders in science throughout history,
2) contemporary social issues involving technological development, and
3) the nature of scientific enterprise

LEARNING PROCESSES

CENTRAL FOCUS
Emphasize:
Observation
Classification
Ordering
Measuring
Keeping Data
Introduce:
COMMUNICATION — EXCHANGE INFORMATION VERBALLY OR NON-VERBALLY BY USING SEQUENTIAL SCIENTIFIC STEPS
INFERENCE — EXPLANATION OF AN OBSERVATION IN TERMS OF THE RELATIONSHIPS OF DATA COLLECTED
PREDICTION — THE ESTIMATION OF FUTURE EVENTS BASED ON THE RELATIONSHIPS OF DATA COLLECTED

AFFECTIVE DOMAIN

ATTITUDES

CENTRAL FOCUS
Provide experiences for growth of:
Curiosity
Honesty
Imagination
Concern/care
Self-confidence
Persistence

PSYCHOMOTOR DOMAIN

MANIPULATIVE SKILL

CENTRAL FOCUS
Skills which would enable students to handle materials appropriate for level of development, i.e., using microscope, metric equipment, heat source, glassware, charts and simple graphs, reference materials and resource people, compass and calculator
Devising and constructing simple apparatus for experiments

EXIT OBJECTIVES:

The student will be able to:

COGNITIVE DOMAIN

1) communicate in a sequential manner verbally and/or non-verbally
2) explain the same relationships between observations
3) predict a future happening based on data collected

AFFECTIVE DOMAIN

Demonstrate the growth of attitudes, i.e., curiosity, honesty imagination, persistence and concern/care

PSYCHOMOTOR DOMAIN

Handle materials appropriate for physical development

FIFTH GRADE (cont.)

EXAMPLE:

Use simple graphs as a form of communicating data

Use microscopes and other simple apparatuses in experiments

Materials which could be used: microscope, metric equipment, heat sources, glassware, charts, simple graphs, reference materials, resource people, compass, calculator, etc.

SIXTH GRADE

GENERAL CHARACTERISTICS OF STUDENT:

MENTAL

Loyalty to gang
Hero worship
Better ability to make judgment
Self-conscious
Desires to be independent and strong
Struggles between realistic and idealistic

PHYSICAL

Increased muscular coordination
Sexual characteristics developing
Rapid growth
More proficient in manipulative skills

OBJECTIVE: The Sixth Grade science program will enable students to acquire and refine the following:

COGNITIVE DOMAIN

CONCEPTS

CENTRAL FOCUS
Begin concept formation of:
Interaction
Variable
Systems/subsystems
Environment
Energy
Matter
Space/time
Cause/effect
Additional Focus:
1) leaders in science throughout history,
2) contemporary social issues involving development, and
3) the nature of scientific enterprise

LEARNING PROCESSES

CENTRAL FOCUS
Emphasize:
Observation
Classification
Ordering
Measuring
Keeping Data
Communication
Inference
Prediction
Introduce:
ANALYZING — SEARCHING FOR PATTERNS OR RELATIONSHIPS IN THE DATA COLLECTED

AFFECTIVE DOMAIN

ATTITUDES

CENTRAL FOCUS
Provide experience for growth of:
Curiosity
Honesty
Imagination
Concern/care
Self-confidence
Persistence

PSYCHOMOTOR DOMAIN

MANIPULATIVE SKILL

CENTRAL FOCUS
Skills which would enable students to handle materials appropriate for level of development, i.e., using microscope, thermometers, meter sticks, balance, volumetric equipment, timing devices, cameras, compasses, calculators, audiovisual equipment, reference materials and resource people, and heat sources.
Devising and constructing simple apparatus for experiment.
Construction of charts and graphs

EXIT OBJECTIVES:

The student will be able to:

COGNITIVE DOMAIN

See patterns or relationships in the collection of data

AFFECTIVE DOMAIN

Demonstrate the growth of attitudes, i.e., curiosity, honesty, imagination, persistence and concern/care

PSYCHOMOTOR DOMAIN

Handle materials appropriate for level of physical development

EXAMPLE:

Activities which show how science is related to other curriculum areas, i.e., structures in Art and Science, photography in the classroom, testing for starches, sugars, bases; graphing experiment results

Materials which can be used: microscopes, thermometers, meter sticks, volumetric equipment, timing devices, cameras, compasses, calculators, etc.

SEVENTH AND EIGHTH GRADES

GENERAL CHARACTERISTICS OF STUDENT:

MENTAL

Self-conscious at times
Wants peer approval
Wide fluctuation in emotions
Indifferent
Outgoing
Over generous
Have tendency to leave a situation when under emotional stress

PHYSICAL

Rapid growth — causes some lack of coordination
Continual refinement of eye-hand eye-foot coordination
Aware of physical growth
Boys are starting to mature
Girls are generally ahead of boys in development

OBJECTIVE: The Seventh and Eighth Grade programs will enable students to acquire and refine the following:

COGNITIVE DOMAIN

CONCEPTS

CENTRAL FOCUS
Begin concept formation of:
Interaction
Variable
Systems/subsystems
Environment
Energy
Matter
Space/time
Cause/effect

ADDITIONAL FOCUS
1) leaders in science throughout history,
2) contemporary social issues involving technological development, and
3) the nature of scientific enterprise

LEARNING PROCESSES

CENTRAL FOCUS
Emphasize:
Observation
Classification
Ordering
Measuring
Keeping data
Communication
Inference
Prediction
Analyzing
Introduce:
HYPOTHESIZING — FORMULATING A TESTABLE PREDICTION

AFFECTIVE DOMAIN

ATTITUDES

CENTRAL FOCUS
Provide experience for growth of:
Curiosity
Honesty
Imagination
Concern/care
Self-confidence
Persistence

PSYCHOMOTOR DOMAIN

MANIPULATIVE SKILL

CENTRAL FOCUS
Refinement of all skills safely using materials and scientific tools appropriate for seventh and eighth grades

EXIT OBJECTIVES:

The student will be able to:

COGNITIVE DOMAIN

1) formulate a testable prediction
2) demonstrate an understanding of some of the concepts listed

AFFECTIVE DOMAIN

Demonstrate the growth of attitudes, i.e., curiosity, honesty, imagination, persistence and concern/care

PSYCHOMOTOR DOMAIN

Handle materials appropriate for physical development

EXAMPLE:

Students set up and demonstrate experiments using the scientific method

NINE THROUGH TWELVE GRADES — SECONDARY

GENERAL CHARACTERISTICS OF STUDENT:

MENTAL

More self-confident
Determined
Discriminating
Self-controlled
More analytical about emotions
Good self-evaluators
Like to compete
More verbal
Think logically
Start to carry out symbolic operations mentally

PHYSICAL

Fine muscle control refined
Reach maturity

OBJECTIVE: The Secondary science program will enable students to acquire and refine the following:

COGNITIVE DOMAIN		**AFFECTIVE DOMAIN**	**PSYCHOMOTOR DOMAIN**
*CONCERNS**	*LEARNING PROCESSES*	*ATTITUDES*	*MANIPULATIVE SKILL*
CENTRAL FOCUS	*CENTRAL FOCUS*	*CENTRAL FOCUS*	*CENTRAL FOCUS*
Cause/effect	Observation	Persistence	Refinement of all skills safely with the use and care of appropriate laboratory equipment
Change	Classification	Concern/care	
Cycle	Ordering	Self-confidence	
Energy/matter	Measuring	Curiosity	
Entrophy	Keeping data	Honesty	
Equilibrium	Communication		
Force	Inference		
Fundamental particles	Prediction		
Interaction	Analyzing		
Model	Hypothesizing		
Orderliness			
Organism			
Probability			
Population			
Quantification			
Replication			
Scale			
Symentry			
System			
Theory			
Time/space			

	Use of safety in laboratory
	Use of some instrument that records data as a function of time, such as a polygraph
	Use of some electronic instrument that measures current as a function of some other physical variable, such as a pH meter

* *From "What Is Unified Science Educational? (Part 5) Program Objectives and Scientific Literary" by Victor Showalter in collaboration with David Cox, Paul Holobrinko, Barbara Thomson and Mike Oriedo*

NINE THROUGH TWELVE GRADES — SECONDARY (cont.)

EXIT OBJECTIVES:

The student will be able to:

COGNITIVE DOMAIN	AFFECTIVE DOMAIN	PSYCHOMOTOR DOMAIN
1) demonstrate an understanding of most of the concepts which lead to scientific literacy 2) exhibit an understanding of the learning processes involved with becoming scientifically literate	Demonstrate the growth of attitudes, i.e., curiosity, honesty, imagination, persistence and concern/care	Handle materials appropriate for physical development

EXAMPLE:

Curriculum areas taught at the high school level

DISTRICT GUIDE USING STATE GUIDE AS A MODEL FOR DEVELOPMENT

INTRODUCTION

This guide was developed as a guideline for teaching science. The science textbook as well as other materials should be used as a resource that deals in the areas of Life Science, Earth Science, and Physical Science.

By emphasizing scientific method skills we will generate a positive attitude in science.

This will lead to a scientific literacy, which will enable students to be able to make practical decisions that will affect their daily lives involving a variety of careers.

The overall science objectives which instructors and students graduating from Belleville High School will strive to attain are as follows:

To create interest in the science field.

To teach students the scientific method skills.

To prepare students for college.

To give each high school student a general understanding of the physical sciences and biological sciences.

To encourage individual thought and creativity.

To develop laboratory skills.

To introduce students to various careers in the sciences.

U.S.D. 427

Science Curriculum Committee

Ramona J. Anshutz - Kansas State Department of Education
Laveda Cornett - Fourth Grade
Jean Popelka - Fifth Grade
Betty Zenger - Sixth Grade
Delore Patton - Seventh and Eighth Grade
David Kadavy - High School
Frank Filipi - High School
U.S.D. 427 Principals

U.S.D. 427
OVERALL SCIENCE GOALS

The U.S.D. 427 science program will:

I. Stimulate the natural curiosity of the student in the phenomenon of science.

II. Develop the scientific skills of science through:
- A. *Observing* — Identifying and describing properties of objects through the use of the senses — size, shape, color, texture, sight, smell, taste, hearing.
- B. *Classifying* — Sorting and arranging according to common properties and characteristics.
- C. *Ordering* — Arranging in series of sequence.
- D. *Keeping Data* — Recording observations accurately.
- E. *Measuring* — Assigning numbers according to rules.
- F. *Communicating* — Describing orally or in written form by drawing and diagramming an object or idea for the understanding of others.
- G. Inferring — Making a judgment or relationship of collected data.
- H. *Predicting* — Estimating the future events using data collected.
- I. *Analyzing* — Systematically searching for relationships among the data.
- J. *Hypothesizing* — Making a testable prediction.
- K. *Experimenting* — Recognizing an appropriate sequence related to the laboratory investigation anywhere the investigation would take place.
- L. *Interpreting Data* — Describing information found in data.

III. Create an awareness of *total environment* and how the environment affects the student.

IV. Provide basic concepts in science.

V. Provide hands-on experiences in working with materials.

VI. Implement practical application.

VII. Develop the following attitudes:
- A. Curiosity
- B. Care, concern and appreciation
- C. Self-discipline, responsibility
- D. Objectivity
- E. Persistence
- F. Independent learning
- G. Safety

KINDERGARTEN

Skills:
Observing

Goal:
The goal of kindergarten is to develop an awareness in the student through the first step of scientific method — *observation.* (compare)

Skill Objectives:
The student will be able to:

I. *Discriminate likenesses and differences through observation by:*
   A. *Identifying objects by property:* (using 5 senses)
      1. *shape*
      2. *size*
      3. *color*
      4. *texture*
      5. *smell*
      6. *sound*
      7. *sight*
      8. *quantity*
      9. taste
   B. *Counting (1-50)*
   C. *Sequencing (large to small — small to large) events*

II. *Understanding spatial relationships:*
   A. *On*
   B. *Over*
   C. *Under*
   D. *Between*
   E. *Beside*
   F. *Behind*
   G. *In front*
   H. *On a line*
   I. *On top*
   J. *Off*

III. *Describe objects orally by:*
   A. *Size*
   B. *Sound*
   C. *Smell*
   D. *Texture*
   E. *Color*
   F. *Shape*

Units:

I. *Life Science*
   A. *Leaves*
   B. *Seeds - beginning awareness*
   C. *Insects*
   D. *Soil*
   E. *Water*
   F. *Animals*

II. *Physical Science*
   A. *Sink and float*
   B. *Introduction of magnets*

III *Earth Science*
   A *Rocks*

IV *Space Science - Introduce:*
   A. *Weather*
   B. *Seasons (record temperature, discuss dress)*

V Learning Objectives
   A The student will share responsibilities and tasks and use materials in a safe manner.
   B The student will identify the body organ associated with each of the five senses, and use the senses to observe and describe common objects.
   C. The student will describe an object on the basis of color, shape, texture, size, and position.
   D. The student will sort and compare objects using one variable - length, width or weight, (sequencing) large to small - small to large.
   E. The student will compare 2 concrete objects by using terms which refer to length, width, size, weight (large to small).
   F. The student will compare objects as floating and sinking while participating in water activities.
   G. The student will compare objects as attracted or not attracted by a magnet while working with a magnet.
   H. The student will observe that the form of an object can be changed. Piece of clay - show can change to ball or flat.
   I. The student will observe and describe daily weather conditions.
      (a) What dress to wear on certain kinds of days.
      (b) Teachers will record temperature and student will discuss.
   J. The student will describe the characteristics of living things and identify familiar as living and non-living. An awareness that living things grow and need food, water and air to survive is required.
   K. The student will describe some ways in which living things change as they grow and develop. (color, size, shape, and texture)
   L. The student will match parents and their offsprings. (animals)
   M. The student will observe and describe similarities and differences between various environments. (home, city, school, etc.)
   N. The student will demonstrate ways to conserve energy and natural resources which are commonly used.
      1. Turn off lights and water after using.
      2. Close doors.
      3. Not waste paper, etc.
      4. Food.

VI. *Health*
   A. *Cleanliness*
   B. *Dental care*
   C. *Proper toilet care*
   D. *Manners*

Skills:
Observing

Concepts:
Introduce matter
Time/space

FIRST GRADE

Skills:
Observing
Classifying

Goal:
The goal of first grade is to enable students to acquire and refine skills of observing with the *introduction of classifying.*

Skill Objectives:
The student will be able to:

I. Discriminate likenesses and differences by using the five senses.

II. Sort and arrange according to common properties.
- A. Sort objects by color, shape, size, sound, taste, smell, texture, and sight.
- B. Identify objects according to properties using senses.
- C. Describe objects according to color, shape, size, sound, taste, smell, texture, and sight.
- D. Sequencing (small to large - large to small) size.
- E. Matching sets of objects.
- F. Counting (1-100)

Units:

I. Life Science
- A. Plants
  1. Leaves
  2. Seeds
  3. *Trees*
- B. Animals
  1. *Birds*
  2. *Mammals*

II. Physical Science
- A. Magnets (*attract/repel*)
- B. *Simple machines*

III. Earth Science
- A. Rocks - *classify by shape and color*
- B. *Soil - classify by weight, heaviness, color, texture (coarse or fine).*

IV. Space Science
- A. Weather
- B. Seasons

V. Learning Objectives
- A. The student will share responsibilities and tasks, and use materials in a safe manner.
- B. The student will classify objects according to opposite properties.
- C. The student will put in order a collection of at least three like objects according to size or weight and describe them.
  - (a) Smallest to largest.
  - (b) Lightest to heaviest.
  - (c) Shortest to tallest.
- D. The student will classify events in which he participates according to time categories such as morning, noon, or night, day of the week, or season of the year.
- E. The student will demonstrate that the wheel and the inclined plane are used to make work easier and identify their uses in common objects.
- F. The student will demonstrate that some common materials dissolve in water and some do not.
  - (a) Common materials such as salt, sugar, dirt, sand, rocks, and oil should be used.
- G. The student will identify sounds as loud or soft, and high or low.
- H. The student will identify the four seasons and observable seasonal changes.
- I. The student will compare size, shape, and texture of small green plants.
- J. The student will compare size, shape, color, sound, texture of different animals.
- K. The student will tell ways in which various living things are affected by their environment.
  1. Using examples - (plant- water, not water)
  2. In light or dark.
- L. The student will demonstrate ways to conserve energy and natural resources.
  1. Turn off water and light.
  2. Food.
  3. Paper.

VI. Health
- A. *Human body*
  1. Dental care
  2. Toilet care
  3. Manners
  4. *Introduce nutrition (very basic level)*

Skills:	*Concepts:*
Observing	Space/time
Classifying	Matter
	Energy
	Ordering

SECOND GRADE

Skills:
Observing
Classifying
Ordering

Goal:
The goal of second grade is to enable the student to acquire and refine the skills of observing and classifying with the introduction of ordering.

Skill Objectives:
The student will be able to:

I. Make comparisons by:
- A. Size
- B. Color
- C. Shape
- D. Texture
- E. Taste
- F. Quantity
  1. numbers (spatial
  2. counting relationship)

II. Arrange or identify by (largest-smallest) order according to:
- A. Size
- B. Color
- C. Shape
- D. Texture
- E. Taste
- F. Quantity
  1. numbers
  2. counting

III. *Arrange or identify by patterns according to:*
- A. Size
- B. Color
- C. Shape
- D. Texture
- E. Quantity
  1. numbers
  2. counting
- F. *Begin graphing*
  1. *Bar graph without numbers*

Units:

I. Life Science
- A. Plants - *Food chains*
- B. Seeds (*transported*)
- C. Leaves - *Parts*
- D. Animals - *Food chains*

II. Physical Science
- A. *Electricity*
  1. *Introduce batteries and bulbs*
  2. *Conservation*
- B. Simple machines
  1. *Lever (teeter board)*
  2. *Pulley (flag)*

III. Earth Science
- A. Rocks
- B. Soil - *land*
  1. *Conservation*
- C. Water
  1. *Conservation*

IV. Space Science
- A. *Air*
  1. *Pollution*
- B. *Solar System*
  1. *Planets*
- C. Weather - *How it effects plants, seeds, leaves, and animals.*
- D. Seasons

V. Learning Objectives
- A. The student will share responsibilities and tasks, and use materials in a safe manner.
- B. The student will observe and describe changes that take place over time.
- C. The student will select the appropriate instruments used to make measurements of length, weight, volume, temperature.
- D. The student will observe physical events.
- E. The student will classify and observe substances as solids, liquids, or gases.
- F. The student will observe and describe simple changes in matter from one state to another.
- G. The student will describe the effect of seasonal changes on himself and his environment.
- H. The student will demonstrate proper care and handling of living organisms and show respect for life.
- I. The student will know that green plants produce and store food.
- J. The student will know that there are different kinds of pollutants in the environment.
- K. The student will describe and demonstrate some general characteristics of electricity.
- L. The student will demonstrate that lever and pulley are used to make work easier and identify their uses in common objects.
- M. The student will be able to describe the weathering formation of soil from the rocks.

VI. Health
- A. *Dental Hygiene*
  1. *Visiting dentist*
  2. *How to brush*
  3. *What foods are good for teeth*
- B. Human Body
  1. Nutrition
     A. Four food groups

Skills:	*Concepts:*
Observing	Matter
Classifying	Energy
Ordering	Ordering
	Space/Time
	Grouping
	Graphing

THIRD GRADE

Skills:
Observing
Classifying
Ordering
Collecting Data

Goal:
The goal of third grade is to enable the student to acquire and refine the skills of observing, classifying, and ordering with the *introduction of collecting data.*

Skill Objectives:
The student will be able to:

I. Collect data from observations of:
  A. *Environmental Changes*
    1. *Temperature*
    2. *Location*
    3. *Order/measure in sequence with linear measurement metric*
    4. *Properties*
  B. *Variable Changes*
    1. *Temperature*
    2. *Location*
    3. *Measurement*
    4. *Properties*

II. *Keep Records*
  A. *Record data, interpret, and compare box graphs for group data. (Simple bar graph - do in groups)*

Units:

I. Life Science
  A. *Plants in their environment*
    1. *Change*
    2. *Temperature (non-calibrated)*
    3. *Location*
  B. *Animals and humans in their environment*
    1. *Change*
    2. *Temperature*
    3. *Location*

II. Physical Science
  A. Electricity
    1. Batteries and bulbs *(circuits)*
    2. Conservation
    3. *Safety*
  B. Simple machines - *how they work*
    1. Pulley
    2. Lever
    3. *Wedge*
    4. *Incline plane*

III. Earth Science
  A. Land
    1. *Environmental changes*
    2. *Types of rocks in different areas*
    3. *Conservation wise use - proper use*
  B. Water
    1. Conservation wise use

IV. Space Science
  A. Air
    1. Weather
    2. Seasons
    3. Pollution
  B. Solar System (Planets and names)
    1. *Compare and contrast*
      a. *Temperature*
      b. *Atmosphere*
      c. *Size*
      d. *Shape*
  C. *Introduce concept of Gravity*

V. Learning Objectives
  A. The student will share tasks and responsibilities, and use materials in a safe manner.
  B. The student will observe and classify objects into the sets and subsets of similar characteristics (with concrete objects).
  C. The student will use basic units of measurements in classroom and real world situations.
    1. The units should be: length to the nearest cm, weight to the nearest gm, volume to the nearest liter, and temperature to the nearest degree centigrade.
  D. The student will collect data and describe information gathered from first-hand experiences.
  E. The student will describe a given object's position in relation to self.
  F. The student will place natural events in order and use the sequence to tell what comes next.
    1. Animal growth, plant growth, and geological changes, may be used to identify sequence.
  G. The student will identify the types of simple machines and demonstrate the use of each.
  H. The student will describe the relation of planets to the sun.
  I. The student will identify the major components of soil and describe the importance of soil to life on earth.
  J. The student will observe and describe how animals behave in different ways to meet their life needs.
  K. The student will describe a simple food chain.
  L. The student will know that species of plants and animals may become endangered or extinct.
    1. Study of this topic should include possible reasons for extinction and examples of what is being done to protect endangered species today.
  M. The student will know that different populations of plants and animals are found in different environments.

VI. Health
  A. Dental Hygiene
    1. *Decay*
    2. *Regular check-ups*
  B. *Introduce body systems*
    1. *Circulatory*
    2. *Digestive*
    3. *Respiratory*
    4. *Nervous*
  C. Food Groups
    1. Develop four basic food groups

Skills:	*Concepts:*
Observing	Matter
Classifying	Energy
Ordering	Space/Time
Collecting	Measuring
	Variables
	Graphing

FOURTH GRADE

Skills:
Observing
Classifying
Ordering
Collecting Data
Measuring (numbers)

Goals:
The goal of fourth grade is to enable the student to acquire and refine the skills of observation, classification, ordering, collecting data and *introduction to measuring.*

Skill Objectives:
The student will be able to:

I. ***Measure by assigning numbers to properties according to rule.***
II. Collect and sequence data.
III. Record and sequence observations accurately.

Units:

I. Life Science
  A. *Plant growth*
  B. Insect world
    1. *Describe*
    2. *Stages of development*
  C. *Living and non-living objects*
    1. *How environment effects life style*

II. Physical Science
  A. Machines
    1. Continue working with simple machines
    2. *Application of simple machines*
  B. Electricity
    1. Circuits
  C. Magnets
    1. *Map magnetic field using electro-magnet, iron filings, and newsprint*
    2. *Magnetic pull - N. Pole-S. Pole*

III. Earth Science
  A. Rocks
    1. *Identify characteristics*
    2. *Name characteristics (texture, color, size, shape)*
    3. *Measurement*
  B. Land
    1. *Identification of formations (prairie, mountainous, flood plain)*
    2. Conservation
  C. Water
    1. Uses and effects
    2. *Pollution*
    3. Conservation

IV. Space Science
  A. Weather
    1. *Air currents and their effects*
    2. Graphs - *read graphs dealing with weather*
    3. Temperature
      a. *Keep record of temperature* (use calibrated thermometer)
      b. *Chart on daily basis*
  B. Solar system
    1. *Astronomy*
      a. *Planets and their effects on the earth*
      b. *Outerspace*

V. Learning Objectives

A. The student will identify and select tasks and responsibilities, and use materials in a safe manner.
  1. The intent is to help students learn to work cooperatively and with some degree of self-reliance in a group.
B. The student will interpret data.
C. The student will conduct simple experiments using only one variable.
D. The student will collect data, sequence and interpret.
E. The student will select the appropriate tool, take a measurement, and report it using the appropriate unit.
F. The student will identify and describe simple circuits.
G. The student will describe the relationship between temperature and the three different states of matter.
H. The student will describe the basic components of the solar system.
  1. This should include relative sizes and positions of the sun, planets, and moons, but students should not be required to learn diameters, distances or other specific facts. The concept of gravity as a force in the solar system should be included.
I. The student will describe some major events and contributors to space exploration and know some indirect benefits of the space program. (enrichment)
  1. Spin-offs in fields such as medicine, computer science, and solar energy should be included.
J. The student will describe ways in which the earth's surface is constantly changing.
K. The student will know the basic parts of plants and their function.
  1. Roots - draw in nutrients and water
  2. Stems - transportation of nutrients and water
  3. Leaves - produce food (photosynthesis)
  4. Flowers/seeds - reproduction
L. The student will describe ways in which populations of plants and animals in a community interact with one another and with their environment.
M. The student will know that plants and animals produce offspring that are alike in major ways but vary enough to be individuals.
  1. Careful examination of plants or animals of the same species should be conducted to observe individual similarities and differences.

VI. Health
  A. Body systems
    1. Digestive
    2. Circulatory
    3. Nervous
    4. Respiratory
  B. *The effects of smoking, diet,* and *drugs on the above systems.*

Skills:	*Concepts:*	
Observing	Matter	Subsystems
Classifying	Energy	Variables
Ordering	Space/Time	
Collecting Data	Graphing	
Measuring	Systems	

FIFTH GRADE

Skills:
Observing
Classifying
Ordering
Collecting Data
Measuring
Communicating
Inferring

Goal:
The goal of fifth grade is to enable the student to acquire and refine the skills of observation, classification, ordering, collection, and measuring to nearest unit, and the *introduction of communicating and inferring.*

Skill Objectives:
The student will be able to:

I. Exchange information verbally and/or nonverbally by using the scientific skills of observation, classification, ordering, collecting data, measuring, *communicating, and inferring.*
II. *Describe the properties of an object in sufficient detail so that it may be communicated with minimal information.*
III. *Make inferences*
  A. *Identify observations that support an inference.*
  B. *Construct inferences from sets of observations.*

Units:

I. Life Science
  A. Animals
    1. *Classifying living things*
      a. Mammals
      b. Birds
      c. *Reptiles*
      d. *Fish*
      e. *Amphibians*
      f. *Insects*
      g. *Others*
  B. *Ecology - Interdependence of living things*
    1. Food chains
    2. Food or energy
    3. *Habitats*
    4. Environmental change
    5. *Ocean environment*
  C. Plants

II. Physical Science
  A. Electricity and magnetism
    1. Circuits - *series and parallel*
    2. *Conductors and non-conductors*
    3. Electromagnet
    4. Magnetic properties
    5. Magnetic field and lines of force
  B. Sound waves
    1. *Transfer of sound waves through air*
    2. Sound communication through
      a. *Telegraph*
      b. *Telephone*
      c. *Radio waves*
      d. *Satellite*

III. Earth Science
  A. Weather and Climate
    1. Weather conditions
    2. *Climate - average condition of atmosphere over a period of time*
    3. *Water cycle*
      a. *Evaporation*
      b. *Condensation*
      c. *Precipitation*
        (1) Air
        (2) Land
        (3) *Acid rain*
        (4) *Chemical pollutants in water*
        (5) Effects on animals
      d. *Clouds and their formations*
    4. *Air Masses*
      a. *Causes*
      b. *Air pressure*
      c. *Fronts*
      d. *Weather map studies*
      e. *Wind*
      f. *Humidity*
    5. Pollution

IV. Space Science
  A. Earth, moon, outerspace
    1. Planet Earth
      a. *Rotation*
      b. *Revolution*
      c. *Axes - Tilt*
      d. *Orbit*
      e. *Day/night*
      f. Seasons
  B. *Our satellite, the moon*
    1. *Phases*
    2. *Relationships between gravitational pull, phases of the moon and the tides*

V. Learning Objectives

A. The student will identify and select tasks and responsibilities, and use materials in a safe manner.
  1. Emphasis should be given to working cooperatively and with some degree of self-reliance.
B. The student will identify the controlled variable and the variables which are held constant in a simple experiment.
C. The student will demonstrate the ability of sound to travel through gases and describe the save nature of sound.
D. The student will describe and demonstrate some properties of magnetism.
E. The student will identify and be able to read basic instruments of weather prediction used by meteorologists.
  1. Instruments to be studied should include the weather map, thermometer, barometer, anemometer, and rain gauge. Students should know the purpose of an hygrometer, but should not be required to determine humidity themselves.

F. The student will identify the basic characteristics of the ocean and describe them.
G. The student will define some of the major characteristics used to classify living things.
H. The student will trace the complete life cycles of some plants and animals.
I. The student will describe how plants and animals have both structural and behavioral adaptations which help them survive.
J. The student will observe basic cloud formations, and will record daily temperature and precipitation over a short period of time.

VI. Health
A. *Appearance - care of*
1. *Skin*
2. *Eyes*
3. *Nose*
4. *Teeth*
5. *Ears*
6. *Hair*
B. Food and nutrition
1. *Energy foods*
a. *Carbohydrates*
(1) *Starch*
(2) *Sugar*
(3) *Lab tests for starch and sugar*
b. *Proteins*
c. *Fats*
d. *Minerals*
2. *Chart food eaten from four basic food groups*
C. Drug awareness
1. Alcohol
2. Tobacco
3. Narcotic drugs

Skills:	*Concepts:*
Observing	Variables
Classifying	Systems and Subsystems
Ordering	Matter
Collecting	Data Energy
Measuring	Space/Time
Communicating	Graphing
Inferring	

SIXTH GRADE

Skills:
Observing
Classifying
Ordering
Collecting Data
Measuring
Communicating
Inferring
Predicting
Analyzing

Goal:
The goal of sixth grade is to enable the student to acquire and refine the skills of observation, classification, ordering, collection, measuring, communicating, and inferring with an emphasis on the *introduction of predicting and analyzing.*

Objectives:
The student will be able to:

I. *Predict*
- A. *Estimate the future events using data collected*
- B. *Name the prediction by observing between time and data events before the range of events*
- C. *Construct a test of prediction*
- D. *Order a set of prediction*

II. *Analyze*
- A. *Search for relationships among the data*
- B. *Search for variables involved*

Units:

I. Life Science
- A. You and your body
  1. Body systems
  2. *Comparison among cells*
  3. *The cycle of life*
  4. *Factors that affect the body*
     a. Alcohol
     b. Tobacco
     c. Drugs
     d. Diet
     e. *Fitness*
- B. *Plants response to the environment*
- C. Animals response to the environment
- D. *Learning ways of surviving*

II. Physical Science
- A. *Forms of energy (kinetic and potential)*
  1. Electrical
  2. *Light*
  3. *Mechanical*
  4. *Heat*
  5. *Nuclear energy*
  6. *Chemical*
- B. *Sources of energy*
- C. *Physical and chemical*
  1. *Changes and properties*
- D. *Fossils*
- E. *Your survival in the future*
  1. *Managing our energy resource*
  2. *Managing our matter resource*

III. Earth Science
- A. *Earth's atmosphere*
  1. *The structure of the atmosphere*
  2. *Composition of air*
  3. Weight and pressure of air
  4. *Temperature*
  5. Humidity
- B. Weather
  1. Sun
  2. Air masses - *jet streams*
  3. Changing weather
- C. Rocks
  1. *Igneous*
  2. *Sedimentary*
  3. *Metamorphic*

IV. Space Science
- A. Solar systems
  1. Relationships with each other
  2. Sun
  3. *Constellations*
- B. Satellites
  1. *Man-made*
  2. Natural

V. Learning Objectives
1. The student will demonstrate safety procedures in the use of laboratory equipment and materials, while working individually and in groups.
   a. Students, working individually and in small groups, will use proper safety procedures with equipment and materials such as:
      (1) Laboratory glassware
      (2) Heating devices
      (3) Thermometers
      (4) Acids
      (5) Bases
      (6) Oxidizers
2. The student will use process skills as a basis for solving problems.
3. The student will use appropriate materials, tools, and units of measurement in conducting scientific observations.
   a. Tools to be used are:
      (1) Metric rulers
      (2) Hand lenses
      (3) Balances
      (4) Graduated containers
      (5) Microscopes
4. The student will use various resources to explore topics of personal interest and career opportunities in areas of science.
5. The student will observe changes and classify them as chemical or physical.
6. The student will use observation and experimentation to determine chemical and physical properties of substances.
7. The student will determine the relationship between changes in temperature and the states of matter for given substances.

SIXTH GRADE (cont.)

8. The student will determine electrical energy consumption using common units.
9. The student will observe materials and classify them as mixtures or nonmixtures.
10. The student will define kinetic and potential energy and then state examples of each.
11. The student will identify the life processes of organisms.
12. The student will describe the dependence of organisms upon non-living things.
13. The student will describe the differences and similarities between plants and animals.
14. The student will describe the interaction and interdependence of plants and animals.
15. The student will compare and contrast natural cycles.
16. The student will describe the movements of the earth, sun, and moon.
17. The student will describe the gravitational effects of the sun and moon upon the earth's environment.
18. The student will explain positive and negative effects of man's interaction with the environment.
19. The student will describe the uses and conservation of renewable and nonrenewable resources.
20. The student will explain the relationship of the sun to most forms of energy on earth.
21. The student will describe the basic relationship between electricity and magnetism.
22. The student will identify and describe cellular components.

VI. Health - See Life Science Unit

Skills:
Observing
Classifying
Ordering
Collecting Data
Measuring
Communicating
Inferring
Predicting
Analyzing

Concepts:
Variables
Systems and Subsystems
Matter
Energy
Space/Time
Graphing

SEVENTH GRADE

Skills:
Observing
Classifying
Ordering
Collecting Data
Measuring
Inferring
Communicating
Predicting
Analyzing
Interpreting Data
Hypothesizing
Experimenting

Goal:
The goal of the seventh grade is to enable students to acquire and refine the skills of classifying, observing, ordering, collecting and organizing data, measuring, communicating, inferring, predicting and analyzing with the introduction of interpreting data, hypothesizing and experimentation.

Skill Objectives:
The student will be able to:

I. Interpret Data
   A. Describe information shown on a table or graph.
   B. Construct inferences of hypotheses from information given in a table of data, graph or picture.
   C. Construct predictions, inferences or hypotheses from given information.

II. Hypothesize
   A. Construct a hypothesis that is a generalization of observations or inferences.
   B. Construct and demonstrate a test for hypothesis.
   C. Distinguish between observation that support a hypothesis and those that do not.

III. Identify the variable to be controlled.

IV. Construct operational definitions.

V. Construct a report of the experiment including a statement stating whether the data supports the hypothesis.

VI. Construct a new question to be answered of the data.

Units

I. Life Science
   A. Microscope
      1. Parts and use
   B. Cells and cell processes
      1. Cell theory
      2. Cell structure
      3. Cell function and chemistry
      4. Cell division
   C. Life forms
      1. Classification process
      2. Protist kingdom
      3. Plant kingdom and survey of representative phyla
      4. Animal kingdom and survey of representative phyla
   D. Life Systems and processes
      1. Human body systems
      2. Frog dissection
      3. Plant tissues, organs and photosynthesis
   E. Animal and plant reproduction and early development
   F. Heredity and genetic change
   G. Research paper and library work
   H. Ecology
      1. Energy pathways
      2. Matter cycles
      3. Communities, ecosystems and biomes
      4. Pollution, natural resources, and conservation

II. Learning Objectives
   1. The student will continue to use the basic process skills and will be able to employ the integrated process skills as a basis for solving problems or answering questions about the environment.
      a. Basic process skills are:
         (1) Observing - using the five senses
         (2) Measuring - using metric lengths, volume, and weights as appropriate
         (3) Classifying - on the basis of observed differences and similarities
         (4) Communicating - verbal, formal and informal writing, drawings, and graphing
      b. Integrated process skills are:
         (1) Inferring - providing explanations
         (2) Predicting - from graphs and other representations
         (3) Hypothesizing - formulating testable explanations
         (4) Modeling - constructing models to explain or illustrate phenomena
         (5) Interpreting data - through graphs, charts, and other representations
         (6) Experimenting - controlling variables to test hypotheses
   2. The student will demonstrate safe and appropriate use of tools and scientific equipment for making observations about the living environment.
      a. Tools and equipment such as hand lenses, metric rulers, graduates, balances, microscopes, and dissecting instruments.
   3. The student will demonstrate proper handling and care of organisms and show respect for life and property.
      a. Provisions should be made for maintaining healthy organisms, providing for the safety of animals, and exhibiting conduct conducive to on-task work.
   4. The student will work independently and as a member of small and large groups within the classroom, in the laboratory, and during field experiences.
      a. Experiences will provide the opportunity to develop independence and to develop cooperative skills and attitudes as a part of social growth and development.

SEVENTH GRADE (cont.)

5. The student will explore the relationship of life science to student interests, career opportunities, and historical contributions to science.
   a. Suggested activities are field trips, library media, guest speakers, and personal interviews.
6. The student will be able to construct and interpret cell models.
   a. Models that illustrate the following will be examined:
      (1) Osmosis (a kind of diffusion)
      (2) Cell parts
      (3) Mitosis and meiosis
7. The student will investigate the structural and functional organization of living things.
8. The student will determine the relationship between life needs and life functions.
   a. Life needs include food, water, air and space. Life functions include growth, reproduction, response to stimuli, and respiration.
9. The student will recognize the basis for standard classification schemes by grouping plants and animals according to their characteristics and by designing and using a dichotomous (two factor) key.
   a. Physical characteristics to be examined include color, shape, texture, and size. Behavioral characteristics to be examined include locomotion and food getting. Students should be aware of the scientific system for naming living things, but should not be required to memorize scientific names.
10. The student will perform experiments and interpret data illustrating the process of photosynthesis.
    a. Photosynthesis will be examined with respect to:
       (1) Starting materials (carbon dioxide and water)
       (2) Reaction products (sugar, oxygen and water)
       (3) Role of light (energy)
       (4) Role of chlorophyll (energy storage, catalyst)
11. The student will describe the utilization of matter and energy within an organism.
    a. Processes to be examined are:
       (1) Use of the products of photosynthesis as building blocks for carbohydrates, proteins and fats
       (2) Cellular respiration (energy yielding)
       (3) Growth, repair, and locomotion (energy using)
12. The student will illustrate the flow of energy and matter among organisms in food chains, webs, and pyramids.
    a. A variety of diagrams, games, models and investigations should be used.

* Each area should be taught with awareness of environmental science.

13. The student will investigate relationships that exist among members of a population.
    a. Competitive and cooperative interactions are to be examined.
14. The student will investigate relationships among organisms and a biological community.
    a. The basic roles (producer, consumer, and decomposer) of organisms and their ecological niches (predator-prey; parasite-host; symbiotic relationship) should be examined.
    b. The physical factors (light, temperature, rainfall, etc.) which determine freshwater, marine, and land environments.
    c. The structural, functional, or behavioral adaptations which enable organisms to survive.
15. The student will identify the daily, seasonal, and long-term changes which occur in ecosystems, communities, populations, and organisms.
    a. Charts, graphs, pictures, and written/oral descriptions and such changes as growth, phototropism, hibernation, plant dormancy, life cycles, and population fluctuations should be examined.
16. The student will investigate the ways in which man's impact upon environment affects living things.
    a. Activities should include topics such as extinct, endangered, and threatened species, destruction of habitat, and availability of food.
17. The student will describe conservation as a necessary practice in man's attempt to protect and wisely use the living resources of the earth.
    a. Suggested topics are management of renewable resources (reforestation) and protection of endangered species.
18. The student will examine the effects of heredity and environment upon organisms.
    a. Topics to be investigated are:
       (1) Inherited and non-inherited traits
       (2) Mutations and their causes
       (3) The role of genes and chromosomes
       (4) Man's ability to influence genetic patterns

Skills
Observing
Classifying
Ordering
Collecting Data
Measuring
Inferring
Communicating
Predicting
Analyzing
Interpreting Data
Hypothesizing
Experimenting

Concepts:
Graphing
Energy
Matter
Interaction
Probability

EIGHTH GRADE

EARTH SCIENCE

Units

I. Planet Earth
- A. Earth's place in the universe
- B. Shape of the earth
- C. Earth's measurements
- D. Directions and location on Earth
- E. Map projections
- F. Uses of maps
- G. *Introduction to topographic maps*

II. Earth Matter
- A. Earth's Chemistry
  - 1. Introduce atoms, elements, and compounds
- B. Minerals identification
  - 1. Characteristics and properties
- C. Rocks
  - 1. Classification
  - 2. Formation
  - 3. Identification

III. Water
- A. Hydrological cycle
- B. Oceanography
  - 1. Composition
  - 2. Currents
  - 3. Topography
- C. Wave actions
- D. Tides

IV. Surface Processes
- A. Weathering
  - 1. Physical
  - 2. Chemical
- B. Erosion
  - 1. Wind
  - 2. Water
  - 3. Ice
- C. Water Systems
  - 1. Rivers
  - 2. Groundwater
- D. Glaciers
  - 1. Development
  - 2. Erosion
  - 3. Deposits

V. Environment
- A. Renewable Resources
- B. Nonrenewable
  - 1. Minerals
- C. Energy
  - 1. Supply - uses
  - 2. Nuclear
- D. Water
  - 1. Atmospheric moisture
    - a. Humidity
    - b. Cloud formations
    - c. Forms of atmospheric moisture

VI. Universe
- A. Solar system
  - 1. motion and bodies
- B. Sun characteristics
- C. Lunar characteristics
- D. Space programs

VII. Earth's Internal Process
- A. Introduction to Plate Tectonics
- B. Earth's internal structure
  - 1. Layers
  - 2. Core
  - 3. Temperature
- C. Volcanoes
  - 1. Causes and effects
- D. Earthquakes
  - 1. Belts
  - 2. Seismograph

VIII. Earth's History
- A. Geologic time
- B. Fossils
  - 1. Formation
  - 2. Time table
- C. Radioactive dating
- D. Principle of Superposition

IX. Learning Objectives
1. The student will exercise safe practices in the correct use of basic laboratory equipment and supplies.
2. The student will apply mathematics in measuring and in problem solving.
   a. Calculating the volume, mass, and density, finding distances and diameters using ratio and proportion formulas, and constructing and interpreting graphs.
3. The student will evaluate the contributions of individuals to earth science fields, investigate career opportunities, and report their findings.
   a. Student will conduct library research.
4. The student will relate natural earth processes to energy sources.
   a. Energy sources resulting from natural earth processes to be included are fossil fuels, geothermal, wind, water, and nuclear.
5. The student will identify and describe major rock forming minerals.
6. The student will apply mineral identification techniques to identify rocks and classify them according to origin.
   a. Rocks to be used are:
      (1) igneous
      (2) sedimentry
      (3) metamorphic
7. The student will communicate knowledge of the rock cycle.

8. The student will describe how the formation of surface structural features relates to the internal nature of the earth and the Plate Tectonics theory.
   a. Structural features are mountains, plateaus, faults, and volcanoes.
9. The student will relate the processes of weathering, erosion, and deposition to soil building, and the movement of water, both on the surface and underground.
   a. Processes and effects to be included are:
      (1) Processes
      Weathering - chemical and mechanical
      Erosion - water, wind, glacial
      Deposition - deltas, moraines, dunes
10. The student will demonstrate skills in reading and interpreting maps.
    a. Laboratory activities will be used with general maps such as topographic, relief, and geologic.
11. The student will interpret major concepts used to describe the geologic history of the earth.
    a. In describing the uses of rocks and fossils the student will emphasize radioactive dating.
12. The student will describe the development of the concept of the universe and various theories of origin.
    a. Theories include Big Bang, Steady State, and Oscillating Universe.
13. The student will identify and describe star systems.
    a. Topics should include galaxies and constellations.
14. The student will describe the size and composition, motion, and measurements of solar system components.
    a. To be included are:
       (1) Size and composition
       Planets (magnetic properties)
       Comets (orbits and periods)
       Moons (size relationships to planets)
       (2) Motion
       Revolution
       Rotation
       Eclipses
       Kepler's laws
15. The student will interpret the hydrologic cycle.
    a. Processes to be included are evaporation, condensation, transpiration, and precipitation.
16. The student will define factors which determine daily weather and climates.
    a. Weather factors
       (1) Barometric pressure
       (2) Wind speed and direction
       (3) Temperature
       (4) Humidity
       (5) Wind circulation
       (6) Air mass movement
    b. Climate factors
       (1) Land masses
       (2) Bodies of water
       (3) Geographical location
17. The student will interpret a weather map.
    a. Factors influencing weather include: fronts, storms, cloud types, pressure, and temperature changes.
18. The student will explain the structure and composition of the atmosphere and the effects of human activities on it.
19. The student will describe bathymetric features common to all ocean basins.
    a. Charts, graphs, models, and drawings will include features such as trenches, ridges, and abyssal plains.
20. The student will describe living systems of sea water.
    a. Living systems
       (1) Food webs
       (2) Estuaries
       (3) Reefs
21. The student will describe the causes and effects of waves, tides, and ocean currents.

HIGH SCHOOL LEVEL INTRODUCTION FOR SCIENCE

NINTH-TWELFTH GRADES

Skills:
Observing
Classifying
Ordering
Collecting Data
Measuring
Inferring
Communicating
Predicting
Analyzing
Interpreting Data
Hypothesizing
Experimenting

Goal:
The goal of the high school science program is to enable students to apply the scientific skills and broaden the knowledge previously acquired at the elementary and middle school levels.

Skill Objectives:
The student will be able to:

I. Demonstrate scientific skills involving practical application
   A. Observing
   B. Classifying
   C. Measuring
   D. Keeping data
   E. Communicating
   F. Predicting
   G. Inferring
   H. Analyzing
   I. Hypothesizing
   J. Experimenting

II. Use the tools of the scientist - assemble and use the appropriate tools, resources, and apparatus needed to investigate a scientific problem.

III. Communicate scientific skills - describe orally, in writing or nonverbally, scientific knowledge, principles, and processes in an effective manner.

IV. Apply scientific knowledge using vocabulary, factual knowledge, theories, and laws, to formulate concepts involving the scientific method to solve problems.

V. Demonstrate scientific attitude - demonstrate a positive attitude toward science through curiosity, objectivity, and persistence.

NINTH GRADE

PHYSICAL SCIENCE

Units

I. Principles of Measurement
   A. Measuring
      1. Length in the metric system
      2. Mass in the metric system
      3. Capacity in the metric system
   B. Computing
      1. Area in the metric system
      2. Volume in the metric system
      3. Density of liquids and solids

II. Optics
   A. Reflection
   B. Refraction
   C. Diffraction
   D. Polarization
   E. Laser

III. Force and motion
   A. The force called gravity
   B. Force, work and power
   C. Molecular forces
   D. Magnetic forces
   E. Rates of events

IV. Chemistry of Matter
   A. Properties and changes of matter
   B. Solutions
   C. Acids and bases
   D. Preparation and properties of gases
   E. Rates of chemical reactions
   F. Equation balancing
   G. Formula writing

V. Forms of Energy
   A. Heat energy
   B. Light energy
   C. Sound energy
   D. Electrical energy
   E. Studying electrical circuits and electronics
   F. Static electricity
   G. Nuclear energy
      1. Half-life
      2. Nuclear decay

VI. Structure of matter
   A. Composition of atom
   B. Crystallin structure
   C. Molecular structure

VII. Organic compounds
   A. Nomenclature
   B. Structural formulas
   C. Types of organic reactions

VIII. Learning Objectives

1. The student will use process skills as a basis for defining and solving problems and answering questions related to the study of the physical environment.
   a. Students will be involved in activities which include the following processes:
      (1) Collecting data
      (2) Distinguishing between observational methods
      (3) Distinguishing among observation, interpretation, and inference
      (4) Identifying and using experimental controls and data
      (5) Formulating conclusions
      (6) Writing reports of scientific investigations
2. The student will demonstrate appropriate and safe use of laboratory techniques and equipment in individual and small group activities.
   a. Techniques and equipment to be considered include the following:
      (1) Laboratory techniques
         Using heat sources
         Handling glassware
         Assembling apparatus
      (2) Laboratory equipment
         Balance
         Burner
         Thermometer
         Metric ruler
         Graduated cylinder
3. The student will make accurate and approximate measures using a variety of instruments and employing direct and indirect methods.
   a. Direct and indirect methods will be used for measuring the following:
      (1) Volume
      (2) Mass
      (3) Length
      (4) Temperature
      (5) Time
4. The student will graph and interpret data from experiments on interacting matter and energy.
   a. Data will be represented appropriately on line, bar or circular graphs. Relationships between variables will be recognized and described.
5. The student will identify characteristics and examples of various types of matter by their physical and chemical properties.
   a. Classes of matter and properties to be investigated are:
      (1) Classes of matter
         Elements, compounds, mixtures
         Acids, bases, salts
         Organic, inorganic
         Solids, liquids, gases
      (2) Physical properties
         Shape
         Density
         Solubility
         Odor
         Melting point
         Boiling point
      (3) Chemical properties
         Acidity
         Basicity
         Combustibility
         Reactivity

6. The student will explain various models that illustrate the structure of an atom.
   a. Representations of the Bohr and cloud models should illustrate:
      (1) The arrangement of electrons, protons, and neutrons
      (2) The Bohr representation of elements 1-8
      (3) Isotopes
      (4) Ions
7. The student will use the periodic chart for obtaining information about elements and inferring information about elements and binary compounds.
   a. Among the information and inferences are:
      (1) Information
         Symbol
         Atomic number
         Atomic weight
         Chemical family
         Chemical group
         Valence
         Metal, non-metal
      (2) Inferences
         Chemical activity
         Physical properties
         Formula of compound
         Name of compound
         Nature of bonding
         Practical uses
8. The student will describe physical, chemical, and nuclear changes using the law of conservation of matter and energy.
   a. Among the factors to be considered are:
      (1) Physical change
         Effect of temperature on state
         Effect of particle size on solubility
         Effect of temperature on solubility
      (2) Chemical change
         Type of reaction
         Evidence of reaction
         Product(s) and reactant(s)
         Balanced equations
      (3) Nuclear Reactions
         Fusion and fission
         Products of reactions (nuclear)
         Effects on man
         Effects on environment
9. The student will investigate energy states and forms and describe how energy is transferred, transformed, and utilized.
   a. The following factors are among those to be considered:
      (1) Energy states
         Kinetic
         Potential
      (2) Energy forms
         Heat
         Light
         Sound
      (3) Energy changes
         Kinetic to potential
         Chemical to electrical
         Heat to light
      (4) Energy utilization
         Domestic
         Commercial
         Industrial
10. The student will investigate the basic characteristics of light, and the technological applications.
    a. Among the characteristics and technological applications to be examined are:
       (1) Characteristics
          Wave nature
          Reflection
          Colors
          Diffraction
          Interference
       (2) Technological applications
          Lasers
          Microscope
11. The student will investigate the characteristics and technological applications of electricity and magnetism.
    a. The following characteristics and applications are among those to be considered:
       (1) Characteristics
          Static electricity
          Current electricity
          Circuits
          Attraction and repulsion
          Lines of magnetic force
       (2) Technological applications
          Motors
          Generators
          Appliances
          Electronics
          Computers
12. The student will investigate the basic characteristics and technological applications of mechanical waves.
    a. The following characteristics and applications are among those to be considered:
       (1) Characteristics
          Reflection
          Refraction
          Interference
          Sound wave motion
          Water wave motion
       (2) Technological applications
          Music
          Communication
          Hearing
          Noise pollution
13. The student will investigate the scientific principles and the technological applications of work.
    a. The following principles and applications to be investigated are:
       (1) Principles
          Work
          Force
          Power
          Horsepower
       (2) Applications
          Simple machines
          Complex machines

14. The student will investigate the basic principles and technological applications of force and motion.
    a. Principles and applications to be examined are:
        (1) Principles of force and motion
            Gravitational forces
            Speed
            Mass
            Force
            Newton's laws of motion
            Velocity
            Acceleration
        (2) Technological applications
            Powered vehicles
            Rockets
            Restraining devices
            Projectiles

15. The student will apply basic physical and chemical principles to describe changes occuring in common substances and to explain the operation of household devices.
    a. Among the changes in common substances and operation of household devices to be considered are:
        (1) Common substances
            Cleaning agents
            Paints
            Food
        (2) Household Devices
            Thermostats
            Refrigerators

16. The student will evaluate past and future effects of science and technology on man and the environment.
    a. The following areas of concern are among those to be considered:
        (1) Nuclear energy
        (2) Organic chemicals
        (3) Space exploration
        (4) Environmental pollution
        (5) Energy conservation

17. The student will utilize research skills to investigate scientific, environmental, or individual selected problems.
    a. Research skills involving scientific processes may be used to investigate the following areas:
        (1) Research skills
            Experimentation
        (2) Areas
            Pollution
            Energy demands
            Nuclear energy
            Food
            Waste disposal
            Housing

18. The student will explore the relationship of physical science to student interest and career opportunities.
    a. Personal interests will be explored using such resources as library media centers, professional scientists (doctors, chemists, nurses, engineers, technicians, educators), businesses, institutions, and agencies.

TENTH, ELEVENTH, AND TWELFTH GRADE

BIOLOGY I

Units

I. Introduction to Biology
   A. History
      1. People
      2. Events and trends
   B. Current events and trends
   C. Practical application
   D. Use of tools and techniques

II. Cells and cell processes
   A. Cell theory
   B. Cell structure
   C. Cell function and chemistry
   D. Cell division

III. Heredity
   A. Meiosis
   B. Genetics
   C. Inheritance

IV. Micro-organisms
   A. Classification
   B. Viruses
   C. Bacteria
      1. Helpful
      2. Harmful
      3. Harmless
   D. Diseases
   E. Protozoans
   F. Fungi
   G. Algae

V. Plants
   A. Mosses and ferns
   B. Seed plants
      1. Structure
      2. Growth and response
      3. Reproduction

VI. Animals
   A. Invertebrates
      1. Sponges
      2. Coelenterates
      3. Worms
      4. Mollusks/Echinoderms
      5. Arthropods
      6. Insects

VII. Vertebrates
   A. Fish
   B. Amphibians
   C. Reptiles
   D. Birds
   E. Mammals

VIII. Human biology
   A. Body systems
   B. Nutrition
   C. Body regulators - glands
   D. Drugs and abuse
   E. Reproduction

IX. Ecology
   A. Biosphere
      1. Interrelationships
      2. Individuals and populations
      3. Communities and ecosystems

X. Research projects

XI. Biology techniques
   A. Preservation of anatomical specimens
      1. Fish
      2. Mammals
      3. Amphibians
      4. Reptiles
      5. Birds
   B. Simple test for organic nutrients
   C. Microscope - use and parts
   D. Use of dicotomous key

XII. Learning Objectives
   1. The student will demonstrate appropriate safety techniques in the handling of chemicals, equipment, and organisms.
      a. Proper safety techniques will be used when dissecting and observing specimens, heating materials, preparing solutions, transferring organisms, and handling glassware.
   2. The student will apply the scientific method to experiments.
      a. Reports, laboratory practicals, investigations and observations will be used to demonstrate the ability to design experiments, interpret data, and draw conclusions.
   3. The student will use appropriate library research skills.
      a. Abstracts, reprints, and journals will be used to prepare written or oral reports.
   4. The student will explore areas of interest and career opportunities in biology.
      a. Field trips, career centers, and guest lecturers will provide information for class discussion and creative writing that will be used to demonstrate an awareness of biology-related careers and individually chosen topics.
   5. The student will understand the characteristic processes which define life.
      a. The following life processes will be topics for experimentation and discussion:
         (1) Reproduction
         (2) Movement
         (3) Assimilation
         (4) Growth
         (5) Response
         (6) Energy transformation
   6. The student will demonstrate an awareness of the importance of historical contributions in the development of the biological sciences.
   7. The student will examine the basic chemical processes which enable organisms to meet their metabolic and developmental needs.

a. Topics for investigation will focus on projects and discussion which focus on prediction and measurement. Topics to be examined include cellular respiration, photosynthesis, carbon cycle, nitrogen cycle, and water cycle.

8. The student will investigate and describe the structure and functions of cells.
   a. Laboratory investigations and drawings, charts, and class discussion are to be used to describe organelles such as cytoplasm, nucleus, mitochondria, and chloroplasts.
9. The student will interpret the organization of cells, tissues, organs, and systems in specified organisms to determine the order of complexity and development of life.
   a. Experimentation, charts, dissections, drawings, discussion, and microscopic investigations are to be used to recognize the differences in complexity among major phyla from the protists kingdom and major classes from plantae and animalia kingdoms.
10. The student will use and be able to explain the basis of the classification of organisms.
    a. The examination of structural similarities and developmental patterns in establishing common ancestry will be presented through the use of charts, microscopic and macroscopic observations, dissections, and discussions.
11. The student will recognize the relationships among reproductive methods adaptation, and the continuation and variation of a species.
    a. Variety in asexual and sexual reproductive methods and the effects each has on the continuation and variation of a species (i.e., alternation of generation, mutation, and cloning) are to be explored.
12. The student will investigate the mechanisms of inheritance.
    a. Experimentation, observation, and library research will be used in compiling pedigrees and solving genetic problems (i.e. DNA, mitosis, homologous chromosomes, dominant and recessive traits, sex-linkage, genotype and phenotype).
13. The student will explain the concept of homeostasis in cells, individuals, populations, communities, and ecosystems.
    a. Topics such as food webs, succession, symbiosis, diffusion, and osmosis will be used.
14. The student will distinguish between learned and innate behaviors.
    a. Behaviors such as conditioning, imprinting, trial and error, tropism, and taxis are to be investigated through experimentation and library research.

TENTH, ELEVENTH, AND TWELFTH GRADE

EARTH SCIENCE

Units

I. Planet Earth
- A. Earth's place in the universe - past and present
- B. Shape of the Earth
  - 1. Effecting forces
  - 2. Spherical characteristics
- C. Earth's measurements
- D. Direction and location on Earth
  - 1. Latitude
  - 2. Longitude
- E. Map projection
- F. Uses of maps
- G. Interpretation of topographical map

II. Materials of the Earth's crust
- A. Earth's chemistry
  - 1. Atomic structure
  - 2. Formation of elements and compounds
  - 3. Physical properties of matter
- B. Minerals
  - 1. Silicate
  - 2. Non-silicate
- C. Mineral identification
  - 1. Characteristics of properties
- D. Rocks
  - 1. Classification
  - 2. Formation
  - 3. Identification

III. Water
- A. Physical and chemical properties
- B. Hydrological cycle
- C. Oceanography
  - 1. Oceans
  - 2. Composition
  - 3. Currents
  - 4. Topography
- D. Wave action
- E. Tides

IV. Surface Processes
- A. Weathering
  - 1. Physical
  - 2. Chemical
- B. Erosion
  - 1. Wind
  - 2. Water
  - 3. Ice
- C. Development of a river system
- D. Life cycle of mountains, plains, and plateaus
- E. Glaciers
  - 1. Continental
  - 2. Valley
  - 3. Features

V. Climatology
- A. Atmosphere
  - 1. Composition
  - 2. Movement
  - 3. Measurement
  - 4. Pollution
- B. Water
  - 1. Atmospheric moisture
    - a. Humidity
    - b. Cloud formation
    - c. Forms of atmospheric moisture
- C. Weather
  - 1. Air masses - origin and influence
  - 2. Instrumentation
  - 3. Forecasting
  - 4. Map interpretation
- D. Climate
  - 1. Types of climate
  - 2. Climatic controls

VI. Universe
- A. Design of solar system
- B. Sun characteristics
- C. Lunar characteristics
- D. Space programs
- E. Characteristics of universe

VII. Earth's internal process
- A. Plate tectonics - cause and effect
- B. Earth's anatomy and composition
- C. Earth's magnetic field - cause and effect
  - 1. Mapping
- D. Volcanoes
- E. Earthquakes

VIII. Earth's History
- A. Geologic time
- B. Fossils
  - 1. Formation
  - 2. Timetable
- C. Radioactive dating
- D. Principle of superposition

IX. Learning Objectives
1. The student will exercise safe practices in the correct use of basic laboratory equipment and supplies.
2. The student will apply mathematics in measuring and in problem solving.
   a. Calculating the volume, mass, and density of a regular and of an irregular solid, finding distances and diameters using ratio and proportion formulas, and constructing and interpreting graphs.
3. The student will do library research in areas contributing to earth science.
4. The student will relate natural earth processes to energy sources.
   a. Energy sources resulting from natural earth processes to be included are fossil fuels, geothermal, wind, water, and nuclear.
5. The student will identify and describe major rock forming minerals using laboratory tools and techniques.
   a. Terminology and Laboratory Techniques
      (1) Crystal structure
      (2) Fracture

(3) Cleavage
(4) Streak
(5) Hardness
(6) Luster
(7) Specific gravity

6. The student will apply mineral identification techniques to identify rocks and classify them according to origin.
   a. Rocks to be used are:
      (1) Igneous - extrusive and instrusive
      (2) Sedimenary - clastic and nonclastic
      (3) Metamorphic - foliated and nonfoliated
7. The student will communicate knowledge of the rock cycle.
8. The student will describe how the formation of surface structural features relates to the internal nature of the earth and the Plate Tectonics theory.
   a. Structural features are mountains, plateaus, faults, and volcanoes.
9. The student will relate the proceses of weathering, erosion, and deposition to soil building, and the movement of water, both on the surface and underground.
   a. Processes and effects to be included are:
      (1) Processes
         Weathering - chemical and mechanical
         Erosion - water, wind, glacial
         Deposition - deltas, moraines, dunes
      (2) Effects
         Soil building - profiles, types
         Karst topography - sinkholes, caves, stalagmites, stalactites
         Water storage - rivers, streams, lakes
10. The student will demonstrate skills in reading and interpreting maps.
    a. Laboratory activities will be used with general and specialized maps such as topographic, relief, and geologic.
11. The student will interpret major concepts used to describe the geologic history of the earth.
    a. In describing the uses of rocks and fossils, emphasize the following:
       (1) Relative dating
          Superposition
          Crosscutting relationships
          Original horizontality
          Uniformitarianism
          Floral and faunal evolution
       (2) Absolute dating
          Carbon 14
          Potassium - Argon
          Uranium 238
12. The student will describe the development of the concept of the universe and various theories of origin.
    a. Theories include Big Bang, Steady State, and Oscillating Universe.
13. The student will identify and describe star systems.
    a. Topics should include galaxies, seasonal and circumpolar constellations, and life cycles.
14. The student will describe the size and composition, and motion of solar system components.
    a. To be included are:
       (1) Size and Composition
          Planets (magnetic properties)
          Comets (orbits and periods)
          Moons (size relationships to planets)
       (2) Motion
          Revolution
          Rotation
          Eclipses
          Kepler's laws
15. The student will interpret the hydrologic cycle.
    a. Processes to be included are evaporation, condensation, transpiration and precipitation.
16. The student will define factors which determine daily weather and climates.
    a. Weather factors
       (1) Barometric pressure
       (2) Wind speed and direction
       (3) Humidity
       (4) Wind circulation
       (5) Air mass movement
    b. Climate factors
       (1) Land masses
       (2) Bodies of water
       (3) Geographical location
17. The student will interpret a weather map and collected data to forecast short range weather changes for the locality.
    a. Factors influencing weather include: fronts, storms, cloud types, pressure, and temperature changes.
18. The student will explain the structure and composition of the atmosphere and the effects of human activities on it.
19. The student will describe bathymetric features common to all ocean basins and use the plate tectonics theory to interpret their origin.
    a. Charts, graphs, models, and drawings will include features such as trenches, ridges, and abyssal plains.
20. The student will describe the physical and chemical properties of sea water and how they affect living systems.
    a. Properties
       (1) Thermal
       (2) Density
       (3) Light filtration
       (4) Composition - minerals, salts, deposits, and sediments
    b. Living systems
       (1) Food webs
       (2) Estuaries
       (3) Reefs
21. The student will describe the causes and effects of waves, tides, and ocean currents.
    a. Waves
       (1) Cause - wind
       (2) Effect - shoreline features
    b. Tides
       (1) Cause - interaction of earth, sun, and moon
       (2) Effects - shoreline features and shipping
    c. Ocean currents
       (1) Causes - upwelling, deposition, and density differences
       (2) Effects - turbidity, salinity, and temperature

ELEVENTH AND TWELFTH GRADE

PHYSIOLOGY

Units

I. Language of anatomy
- A. The body regions
- B. Directional terms
- C. Surface anatomy
- D. Body cavities
- E. The body systems

II. Cells and tissues
- A. Size and shape of cells
- B. Parts of cells
- C. Cell permeability
- D. Cell division
- E. Epithilial tissue
- F. Connective tissue
- G. Muscular tissue
- H. Nervous tissue
- I. Tissue transplant

III. Integumentary or body covering
- A. Anatomy of the skin
- B. Hair and nails
- C. Sweat glands and sebaceous glands
- D. Skin color
- E. Body temperature regulation
- F. How the skin protects
- G. An excretory organ
- H. Absorption by the skin
- I. A sensory organ
- J. Regeneration
- K. Vitamin D

IV. Skeletal system
- A. Functions of
- B. Anatomy of bone tissue
- C. Histology and development of bone
- D. Skeleton and age
- E. Cartilage
- F. Axial skeleton
  - 1. Skull
  - 2. Vertebrae
- G. Appendicular skeleton
- H. Leverage and movement
- I. Teeth

V. Muscular System
- A. Comparison of skeletal, smooth, and cardiac muscle tissue
- B. Anatomy of muscle cell
- C. Nutrient supply of muscles
- D. Chemistry of muscle contraction
- E. Muscle attachment
- F. Muscle movement

VI. Nervous System
- A. Anatomy of the neuron
- B. Chemistry of impulse transmission
- C. Organization of nervous system
- D. Central nervous system
- E. Peripherial nervous system
- F. Autonomical nervous system
- G. Senses

VII. Circulatory systems
- A. Overall plan
- B. Heart
  - 1. Coronary circulation
  - 2. Structure
  - 3. Cardiac cycle
- C. Arterial system
  - 1. Structure
  - 2. Major arteries and organs involved
  - 3. Blood pressure
  - 4. Pressure points
- D. Venous system
  - 1. Structure
  - 2. Major veins and organization
- E. Blood
  - 1. Composition
  - 2. Types
  - 3. Bleeding and clotting
  - 4. Antibodies
- F. Lymphatic system

VIII. Respiratory
- A. Anatomy
- B. Mechanics of breathing
- C. Gas exchange
- D. External effects

IX. Digestive
- A. Anatomy
- B. Digestive process - chemical and physical
- C. Accessory organs of the digestive system
- D. Areas of digestion
- E. The absorption process
- F. Metabolism, foods and nutrition
  - 1. Metabolic rate
  - 2. Calorie requirements
  - 3. Effects of alcohol, caffeine and nicotine
  - 4. Malnutrition

X. Urinary system
- A. Renal system - anatomy and physiology
- B. Ureters
- C. Urinary bladder
- D. Urethra
- E. Physical and chemical properties of urine

XI. Endocrine system
- A. Factors that regulate secretion of hormones
- B. Effects of hormones
- C. Endocrine glands

XII. Reproductive system
- A. Male reproductive system (internal and external)
- B. Female reproductive system (internal and external)

C. Reproductive cycle
D. Pregnancy
E. Embryology

XIII. Human genetics

XIV. Learning Objectives

1. The student will demonstrate appropriate safety techniques in the handling of chemicals and equipment while working as individuals or in groups.
   a. Proper safety techniques will be observed in handling equipment, preparing solutions, and conducting laboratory exercises.
2. The student will conduct experiments using the scientific method.
3. The student will be able to identify the cells and tissue.
   a. **Major cell parts should include plasma, membrane, nucleus, cytophasm, chromosomes, and mitochondria. Identify and name the following tissues: Epithilial, muscular, nervous and connective.**
4. The student will examine the basic integumentary structures.
   a. The topics for focus are skin, hair, nails and subcutaneous gland.
5. The student will investigate and describe the skeletal structure.
   a. Name and identify the major bones of the human body.
6. The student will recognize the relationship of the muscular system and classify them.
   a. Name the origin and insertion of major muscles. Be able to describe the chemistry of a muscle contraction.
7. The student will describe and interpret the nervous system.
   a. Name the function of the major structures of the brain.
8. The student will demonstrate a knowledge of the circulatory system.
   a. Name the major arteries and veins with organs involved.
9. The student will identify and describe the blood.
   a. Blood typing
   b. Blood clotting
   c. Staining
10. The student will describe, interpret, and measure human respiration.
11. The student will investigate and describe the function of the digestive system.
    a. Chemistry involved in digestion of organic compounds.
12. The student will understand the functions of the urinary system.
13. The student will demonstrate a knowledge of hormones and their effect on the body.
14. The student will explain the concepts of human reproduction.
15. The student will explain the variables involved in human characteristics.

ELEVENTH AND TWELFTH GRADE

CHEMISTRY

Units

I. The science of chemistry
  A. Introduce
    1. Chemistry: a physical science
    2. Keystones of modern chemistry
    3. Methods of science
  B. Matter and energy
    1. Concept of matter
    2. Mass and weight
    3. Density of matter varies
    4. Three phases of matter
    5. Properties of matter
    6. Concept of energy
    7. Forms of energy
    8. Conservation of matter and energy
  C. Measurements in chemistry
    1. Metric system - units of the metric system
    2. Temperature and heat-measuring
    3. Uncertainty in measurements
    4. Significant figures
    5. Operations with significant figures

II. Matter and its changes
  A. Composition of matter
    1. Three general classes of matter
    2. Mixtures
    3. The known elements
    4. Two general classes of elements
    5. Chemical symbols
    6. Significance of a symbol
    7. Compounds differ from mixtures
    8. Law of definite composition
    9. Common examples of mixtures and compounds
  B. Changes in matter
    1. Physical changes
    2. Chemical changes
    3. Chemical reactions involve energy
    4. Reaction tendencies
    5. Nuclear changes
  C. Atomic structure
    1. Particles of matter
    2. The atomic theory
    3. The structure of the atom
    4. The characteristics of electrons, protons, neutrons
    5. The nucleus of the atom
    6. Atomic mass
    7. The Avogadro number and the mole
    8. Atomic weight

III. Arrangement of electrons in atoms
  A. Atomic models
  B. Electromagnetic radiation
  C. Spectra of atoms
  D. Wave-mechanics concept of an atom
  E. Quantum numbers
  F. Electron configuration of atoms
  G. Orbital diagram of atoms
  H. Electron dot diagram

IV. The periodic law
  A. Mendeleyev's periodic table
  B. The periodic law
  C. Arrangement of the modern periodic table
  D. Size of atoms: a periodic property
  E. Ionization energy
  F. Ionization energy to remove successive electrons
  G. Value of the periodic table

V. Chemical bonds
  A. Valence electrons and chemical bonds
  B. Ionic bonding (electrovalence)
  C. Energy change in ionic bonding
  D. Oxidation and reduction
  E. Formation of compounds from the elements
  F. Elements with several oxidation numbers
  G. Relative sizes of atoms and ions
  H. Covalent bonding (covalence)
  I. Covalent bonding of unlike atoms
  J. Electronegativity
  K. Electronegativity difference and chemical bonding
  L. Molecular polarity
  M. Polyatomic ions

VI. Chemical composition
  A. Table of ions and their charges
  B. Writing chemical formulas
  C. Writing the formulas for other compounds
  D. Naming compounds from their formulas
  E. Significance of chemical formulas
  F. Molecular weight
  G. Formula weight of a compound
  H. Law of definite composition and the atomic theory
  I. Law of multiple proportions
  J. Mole concept
  K. Determining the empirical formula of a compound

VII. Chemical equations
  A. Formula equations
  B. Factors in equation writing
  C. Procedure in writing equations
  D. General types of chemical reactions
  E. Many reactions are reversible
  F. Stoichiometric relations

VIII. The gas laws
  A. Kinetic theory
  B. Observed properties of gases
  C. Kinetic-theory description of a gas
  D. Attractive forces between gas molecules
  E. Dependence of gas volume on temperature and pressure
  F. Standard temperature and pressure
  G. Variation of gas volume with pressure: Boyle's law
  H. Using Boyle's law
  I. Variation of gas volume with temperature
  J. Kelvin temperature scale
  K. Charles' law
  L. Use of Boyle's and Charles' laws combined
  M. Pressure of a gas collected by displacement of mercury

ELEVENTH AND TWELFTH GRADE (cont.)

N. Pressure of a gas collected by water displacement

IX. Molecular composition of gases
- A. Law of combining volumes of gases
- B. Avogadro's principle
- C. Molecules of active gaseous elements are diatomic
- D. Molecules of the noble gases are monatomic
- E. Molar volume of a gas
- F. Molecular weight of gases determined experimentally
- G. Chemical problems involving gases
- H. Gas volume - gas volume problems
- I. Mass - gas volume problems
- J. Gases not measured at STP
- K. Gases collected by water displacement
- L. The gas constant
- M. Real gases and the ideal gas

X. Liquids - solids - water
- A. Liquids
  1. Properties of liquids
  2. Kinetic-theory description of a liquid
  3. Dynamic equilibrium
  4. Equilibrium vapor pressure
  5. LeChatelier's principle
  6. Boiling of liquids
- B. Solids
  1. Properties of solids
  2. Kinetic-theory description of a solid
  3. Changes of phase involving solids
  4. Amorphous solids
  5. Nature of crystals
  6. Binding forces in crystals
- C. Water
  1. Physical properties of water
  2. Structure and properties of water molecules
  3. Chemical behavior of water

XI. The solution process
- A. Solutions and suspensions
- B. Types of solutions
- C. Solubility
- D. Hydrogen bonds and properties of solvents
- E. Solution equilibrium
- F. Influence of pressure on solubility of gases
- G. Temperature and solubility
- H. Increasing the rate of dissolving
- I. Dissolving mechanisms
- J. Heat of solution
- K. Concentration of solutions

XII. Ionization
- A. Conductivity of solutions
- B. Electrolytes as solutes
- C. Behavior of electrolytes explained
- D. Structure of electrovalent compounds
- E. Some covalent compounds ionize
- F. Strength of electrolytes
- G. Ionization of water
- H. Substances that do not ionize
- I. Effects of electrolytes on the freezing and boiling points of solvents
- J. The degree of ionization

XIII. Acids, bases, and salts
- A. Acids
  1. Importance of acids
  2. Aqueous acids
  3. Modern definition of acids
  4. Properties of aqueous acids
  5. Naming aqueous acids
- B. Bases
  1. Nature of bases
  2. Characteristics of hydroxides
  3. Hydroxides and periodic trends
  4. Relative strengths of acids and bases
- C. Salts
  1. Nature of salts
  2. Salt-producing reactions
  3. Naming salts

XIV. Acid-base titration and pH
- A. Titration
  1. Molar solutions
  2. Chemical equivalents
  3. Normal solutions
  4. Ion concentration in water
- B. pH
  1. The pH of a solution
  2. pH calculations
  3. Acid-base titration
  4. Indicators in titration
  5. pH measurements

XV. Hydrocarbons
- A. Hydrocarbon series
  1. Abundance of carbon compounds
  2. Structural formulas for organic compounds
  3. Determinations of an organic structural formula
  4. Classification of hydrocarbons
  5. Alkane series
  6. Structures of the lower alkanes
  7. Bonding in the alkanes
  8. Alkene series
  9. Alkyne series

XVI. Oxidation-reduction
- A. Reactions
  1. Oxidation and reduction processes
  2. Oxidation and reduction occur simultaneously
  3. Balancing oxidation-reduction equations
  4. Oxidizing and reducing agents

XVII. Radioactivity
- A. Natural radioactivity
  1. Discovery of radioactivity
  2. Nature of the radiation
  3. Decay of atoms of radioactive elements
  4. Applications of natural radioactivity
- B. Artificial radioactivity
  1. Stability of a nucleous
  2. Stable nuclei from radioactive decay
  3. First nuclear disintegration

XVIII. Learning Objectives
1. The student will demonstrate appropriate laboratory techniques and safe use of equipment while working individually and in small groups.

a. Appropriate techniques and safe use will be demonstrated when:
   (1) Handling burners
   (2) Transferring chemicals
   (3) Assembling apparatus
   (4) Causing chemicals to react
   (5) Wearing safety apparel
   (6) Handling glassware
   (7) Using safety equipment (fire blanket, fire extinguishers)

2. The student will conduct and critically evaluate experiments in which variables are measured, analyzed, and controlled.
   a. Activities and investigations should be included which provide the opportunity for:
      (1) Pre-lab assessment
      (2) Identification of variables
      (3) Experimental design
      (4) Assembling apparatus
      (5) Collecting data
      (6) Analyzing data
      (7) Forming conclusions
      (8) Making generalizations
      (9) Evaluating limitations

3. The student will use mathematical skills in solving problems in chemistry.
   a. Emphasis should be placed on using mathematical procedures such as:
      (1) Metric system usage
      (2) Scientific notation
      (3) Arithmetic operations
      (4) Graphing (x,y coordinates)
      (5) Ratio and proportion
      (6) Percentage composition
      (7) Percentage error
      (8) Linear equations
      (9) Significant figures
      (10) Factor-label method

4. The student will model the atom in terms of the location and arrangement of protons, neutrons, and electrons.
   a. Models will illustrate the following features of atoms.
      (1) Mass number
      (2) Atomic number
      (3) Charge
      (4) Size
      (5) Mass
      (6) Isotopes
      (7) Nucleus
      (8) Historical models
      (9) Atomic structure (sub levels, electron configuration using the s, p, d, f model for elements 1-36)

5. The student will use the periodic table to interpret and predict the dependence of chemical and physical properties on electron configuration.
   a. The investigations should include but not be limited to:
      (1) Historical development
      (2) Families/groups
      (3) Series/periods
      (4) Trends and patterns (atomic size, boiling and melting point, reactivity, ionization energy)
      (5) Relationship of electron configuration to valence/combining powers.

6. The student will write chemical formulas for compounds and write balanced equations.
   a. Examination of the following is to be included:
      (1) Chemical Formula
          Symbols
          Coefficients
          Subscripts
          Nomenclature, traditional, and ICE (stock system)
      (2) Balanced equation
          Reactants and products
          Use of combining patterns
          Conservation of atoms and charge
          Exidation and reduction

7. The student will use the molar relationship given in a chemical equation to solve stoichimetric problems.
   a. The following concepts will be developed quantitatively for solving the types of problems listed.
      (1) Concepts/Principles
          Avogadro's principle
          Mole concept
          Proportion and/or factor-label method
      (2) Problems
          Mass - mass
          Mass - volume
          Volume - volume

8. The student will interpret chemical bonding in terms of electrostatic force using appropriate models and notation.
   a. Electron dot and structural models will be used to interpret the following types of bonding.
      (1) Ionic
      (2) Covalent
      (3) Polar convalent
      (4) Hydrogen

9. The student will explain the behavior of matter in each of its three states in terms of the kinetic-molecular model.
   a. The following concepts will be used, as applicable to describe the states of matter:
      (1) Kinetic theory
      (2) Pressure, volume, temperature, mole relationships
      (3) Vapor pressure
      (4) Partial pressure
      (5) Phase change
      (6) Properties and characteristics of phases

10. The student will use the kinetic-molecular theory to explain aqueous solution phenomena.
    a. The concepts of molarity, equilibrim, solubility, and the collision theory model will be explained experimentally and mathematically.

ELEVENTH AND TWELFTH GRADE (cont.)

11. The student will investigate energy relationships by examining energy in physical and chemical changes.
    a. The following should be investigated:
        (1) Endothermic and exothermic changes
        (2) Conservation of energy
        (3) Molar heats of fusion and vaporization
        (4) Kinetic/potential energy conversion.
12. The student will explain the nature and activities of acids, bases, and salts by using the concepts of chemical equilibrim.
    a. The nature of these substances will be described using both the Arrhenius and Bronsted-Lowry Theories. Experimental application of these theories will include consideration of:
        (1) pH function
        (2) Ionization
        (3) Neutralization
        (4) Strong and weak electrolytes
        (5) Indicators
13. The student will explore the application of chemical principles in various occupations and interests.
    a. Explorations and interests include:
        (1) Field trips
        (2) Laboratory
        (3) Photography
        (4) Interviews
        (5) Readings
        (6) Library
        (7) Speakers
        (8) Hobbies
        (9) Crafts

TWELFTH GRADE

PHYSICS

Units

I. The content of physics
- A. Matter
- B. Mass
- C. Inertia
- D. Mass density
- E. Energy
- F. Potential energy
- G. Kinetic energy
- H. Conservation of energy
- I. Relation between matter and energy
- J. Subdivisions of physics

II. Measurement and problem solving
- A. Units of measurement
  1. Physical quantities and units
  2. Length
  3. Mass
  4. Time
- B. Making and recording measurements
  1. Accuracy and precision
  2. Exponential notation
- C. Solving problems
  1. Data, equations and graphs
  2. Vectors
  3. Thinking problems through

III. Nature and cause of motion
- A. Velocity
  1. Nature of motion
  2. Speed and velocity
  3. Velocity
  4. Working velocity problems
- B. Acceleration
  1. Nature of acceleration
  2. Uniformly accelerated motion
  3. Freely falling bodies
- C. Newton's laws of motion
  1. Inertia
  2. Law of acceleration
  3. Law of interaction
- D. Gravitation
  1. Newton's law of universal gravitation
  2. The mass of the earth
  3. Relation of gravity and weight
  4. Gravitational fields

IV. Resolution and composition of forces
- A. Defining forces
- B. Using vectors to represent forces
- C. Resolution of forces
  1. Components of force vectors
  2. Resolving the force vector of gravitational attraction
- D. Composition of forces
  1. Resultant force of concurrent forces
  2. Equilibrant force
- E. Friction
  1. The nature of friction
  2. Principles of friction
  3. Changing friction
  4. Solving friction problems
- F. Parallel forces
  1. Center of gravity
  2. The nature of torque
  3. The second condition of equilibrium
  4. Two forces acting as a couple

V. Curvillinear and harmonic motion
- A. Circular motion
  1. Motion in a curved path
  2. Motion in a circular path
  3. Motion in a vertical circle
  4. Frames of reference
- B. Rotary motion
  1. Motion about an axis
  2. Angular velocity
  3. Angular acceleration
  4. Rotational inertia
  5. Precession
- C. Simple harmonic motion
  1. Periodic motion
  2. Relationship between circular motion and simple harmonic motion
  3. Pendulum - calculations

VI. Conservation of energy and momentum
- A. Work and power
  1. Scientific definition of work
  2. Work done by varying forces
  3. Work done in rotary motion
  4. Scientific meaning of power
  5. Power in rotary motion
- B. Energy
  1. Gravitational potential energy
  2. Measurement of kinetic energy
  3. Kinetic energy in rotary motion
  4. Elastic potential energy
  5. Conservation of mechanical energy
- C. Efficiency of machines
  1. Classes of machines
  2. Efficiency of machines
- D. Momentum
  1. Nature of momentum
  2. Conservation of momentum
  3. Inelastic and elastic collisions
  4. Angular momentum

VII. Phases of matter
- A. Physical forces involved with molecules and atoms
- B. Solids
  1. Nature of solids
  2. Cohesion and adhesion
  3. Elasticity
  4. Hooke's law and elastic modulus

TWELFTH GRADE (cont.)

C. Liquids
1. Nature of liquids
2. Cohesion and adhesion in liquids
3. Surface tension
4. Capillarity
5. Melting
6. Effect of pressure on the freezing point
7. Effect of dissolved materials on the freezing point

D. Gases
1. Nature of gases
2. Vaporization
3. Evaporation and sublimation
4. Equilibrium vapor pressure
5. Boiling

VIII. Thermal effects
A. Temperature and heat measurement
1. Difference between heat and temperature
2. Unit of heat
3. Temperature scales - units
4. Calculation of heat
5. Heat capacity
6. Specific heat - calculation
7. Law of heat exchange

B. Thermal expansion
1. Thermal expansion of solids
2. Thermal expansion of liquids
3. Abnormal expansion of water
4. Problem solving using gas laws

C. Change of phase
1. Phase equilibrium
2. Heat of fusion of ice - calculations
3. Temperature and vapor pressure
4. Heat of vaporization of water - calculations

IX. Heat and work
A. Relation between heat and work - Joule's law
B. First law of thermodynamics
C. Specific heats of gases - calculations
D. Efficiency of ideal heat engines - calculations
E. Second law of thermodynamics

X. Waves
A. Nature of waves
1. Types of waves
2. Characteristics
3. Calculations

B. Wave interactions
1. Properties of waves

XI. *Sound waves
A. Nature of sound
1. Calculations

B. Characteristics of sound waves
1. Fundamentals

XII. Nature of light
A. Waves and particles
1. Properties of light
2. Effects of light

B. Illumination
1. Luminous and illuminated objects
2. Speed of light
3. Light measurements
4. Intensity of a source

XIII. Reflection
A. Properties
B. Images
C. Calculations

XIV. Refraction
A. Optical refraction
1. Nature of optical refraction
2. Refraction and the speed of light
3. Index of refraction
4. Law of refraction
5. Total reflection

B. Lens optics
1. Types of lenses
2. Ray diagrams
3. Images
4. Object-image relationships
5. Applications

C. Dispersion
1. Dispersion by a prism
2. Color of light
3. Color of objects
4. Complementary colors
5. Primary colors
6. Mixing pigments
7. Color vision
8. Chromatic aberration

XV. Electrostatics
A. Electric charge
1. Electrification
2. Two kinds of electric charges
3. Electricity and matter
4. Electroscope
5. Conductors and insulators
6. Transferring electrostatic charges
7. Residual charge by induction
8. Force between charges
9. Electric fields of force

B. Potential difference
1. Electric potential
2. Distribution of charges
3. Effect of the shape of conductors
4. Discharging effect of points
5. Capacitors
6. Dielectric materials
7. Effect of dielectrics

C. Electric circuits
1. Series and parallel
2. Electrical devices
3. Use of instruments
4. A.C. and D.C. - alternating current and direct current

D. Magnetic effects

XVI. Nuclear reactions
- A. Types of nuclear reactions
- B. Uses of nuclear energy

XVII. Learning Objectives

1. The student will demonstrate safe and appropriate use of laboratory techniques and equipment individually and in small groups.
   a. Currently accepted standards for the safe use of laboratory equipment will be followed with particular attention given to the control of hazards associated with electricity, radiation and projectiles.
2. The student will solve problems in physics through the use of mathematics.
   a. Algebraic equations with one unknown, scientific notation, significant digits, and physical unit analysis will be used to solve problems.
3. The student will collect, analyze, and interpret physical data.
   a. The following areas will be included:
      (1) Construct data tables
      (2) Construct rectangular coordinate graphs in two dimensions from data tables
      (3) Interpret the physical relationships between quantities from given graphs and data tables.
4. The student will demonstrate the appropriate utilization of instruments to measure physical quantities.
   a. Such instruments as meter sticks, ammeters, voltmeters, timers, thermometers, spring scales, balances, and graduated cylinders will be used. Absolute and relative error will be calculated.
5. The student will demonstrate the appropriate use of the International Metric System with emphasis on the MKS (meter, kilogram, second) System.
   a. The use of metric units in all measures and calculations is considered appropriate in this course.
6. The student will solve problems involving vectors utilizing trigonometric and/or graphical methods.
   a. The difference between vector and scalar quantities will be identified. Finding the resultant of at least two vectors and resolving a vector into perpendicular components will be included.
7. The student will predict and verify the interrelationships among mass, distance, force and time, using both experimental and mathematical processes.
   a. Quantitative descriptions of the following will be examined:
      (1) Linear motion
      (2) Curvilinear motion
      (3) Newton's Law of Motion
      (4) Work and power
8. The student will describe mathematically the conservation of mass, energy, and momentum, and relate them to physical phenomena.
   a. Topic examination will include applying mathematically the conservation laws and forming hypotheses regarding situations which involve kinetic and potential energy, elastic and inelastic collisions in one and two dimensions, and explosions.
9. The student will investigate and describe properties of solids, liquids, and gases in terms of the kinetic molecular theory.
   a. Investigation should involve:
      (1) Listing the assumptions of the kinetic molecular theory
      (2) Solving mathematical problems involving pressure, volume and temperature relationships
      (3) Describing phase changes in terms of the kinetic molecular theory
10. The student will investigate and describe the application of energy transfer, transformation, and utilization.
    a. The following aspects of energy relationships will be investigated:
       (1) Energy transfer (conduction, convection and radiation)
       (2) Heat of fusion
       (3) Heat of vaporization
       (4) Energy transforming devices (e.g. bulbs, motors, radios, refrigerators) and nature of the transformations
11. The student will interpret data and describe relationships of matter.
    a. Mathematical interrelationships in such laws as F=ma, Boyle's law, and Ohm's law will be verbally stated and mathematically used.
12. The student will identify models of transverse and longitudinal waves and apply these to the interpretation of wave pheonomena.
    a. Wave characteristics such as period, wavelength, frequency, amplitude and phase are to be defined. These characteristics will be used to interpret such wave phenomena as reflection, refraction, diffraction, interference, Doppler effect, standing wave, and polarization. Light and sound will be identified in terms of wave models.
13. The student will identify the main segments of the electromagnetic spectrum.
    a. The main segments of the electromagnetic spectrum such as visible light, radio, micro, infrared, gamma, and ultraviolet will be classified. The major applications of each segment should be recognized.
14. The student will observe and describe the fundamental processes of reflection, refraction, and image formation in optical systems.
    a. The type, size, and position of the images (real or vitual) formed by lenses and mirrors will be identified using ray diagrams and/or the mirror and lens equations. The laws of reflection and refraction are to be investigated.

TWELFTH GRADE (cont.)

15. The student will describe electrical and magnetic fields.
16. The student will diagram and construct simple electrical circuits and explain the function of circuit components.
    a. Ohm's Law will be applied to series, parallel, and combined series-parallel circuits using resistors.
17. The student will understand the relationship of mass and energy.
    a. Principles involved in the relationship $E=mc^2$ will be used to identify instances where mass and energy equivalence is demonstrated, such as in nuclear reactions.

APPENDIX

REFERENCES USED IN PREPARING THIS GUIDE

Crutchfield, R.S., Krech, D., and Livson, N. ELEMENTS OF PSYCHOLOGY. New York: Alfred A. Knopf, Incorporated, c. 1969.

Hunt, J. McV. INTELLIGENCE AND EXPERIENCE. New York: The Ronald Press Company, c. 1961.

Maier, H. W. THREE THEORIES OF CHILD DEVELOPMENT. New York: Harper and Row Publishing, c. 1965.

Muuss. R. C. THEORIES OF ADOLESCENCE. New York: Random House, Incorporated, c. 1962.

Philips, J. L., Jr. THE ORIGINS OF INTELLECT: PIAGET'S THEORY. San Francisco: W. H. Freeman and Company, c. 1969.

Images of Science. A Summary of Results from the 1981-82 National Assessment in Science.

Science Assessment and Research Project. University of Minnesota. Stacey J. Hueftle. Steven J. Rakow and Wayne W. Welch, June, 1983.

A Tool for Assessing and Revising the Science Curriculum. Iowa State Department of Public Instruction. Revised Edition, 1982.

Educating Americans for the 21st Century. A Report to the American People and the National Science Board. The National Science Board Commission on Precollege Education in Mathematics, Science and Technology. 1983.

Standards of Learning Objectives for Virginia Public Schools. Commonwealth of Virginia, Department of Education, Richmond, Virginia. January, 1983.

Focus on Excellence, Volume 1, No. 1. John E. Penick, National Science Teachers Association. 1983.

"SUGGESTED READINGS"
FOR
THE CLASSROOM TEACHER

STATEMENT REGARDING BIBLIOGRAPHIES
by June Level

Bibliographies go out of date as rapidly as books go out of print. When planning changes in the science curriculum, visit with your school library media specialist to ascertain what materials are available in your school and district. Materials can be obtained through interlibrary loan when not locally available.

Library media specialists are constantly concerned with selection of materials that will strengthen the school's collection of materials in all areas. There are several bibliographic sources you might ask to see as well as catalogs from various commercial companies.

Thanks to computer technology, there is a bibliographic resource that indexes on microfilm over 400 journals and periodicals for the last seven years. This resource is available in many public and university libraries. It is called the *Magazine Index*. You will find it much easier to use than the *Readers' Guide to Periodical Literature* and certainly more complete.

Also, remember to utilize the data bases such as Dialog, the Source, CompuServe and ERIC. Consult your school, university or public librarian for more information.

You may wish to learn about instructional television programs available on video tape through Channel 19 in Kansas City, Missouri. 16 mm. films are sometimes available for rent from the University of Kansas Film Library if your district does not have a 16 mm. film library.

A section with software reviews is included in this guide. Consult your school library media specialist for additional software reviews. There are new programs written daily. Reviews of software can be found in all professional periodicals. Several companies such as EPIE and School and HOme Course Ware, Inc. are publishing bibliographies of software reviews.

The school library media program should be an integral part of all curricular planning and implementation.

BIBLIOGRAPHIC RESOURCES IN MOST SCHOOL LIBRARY MEDIA CENTERS

Children's Catalog, Ed. by Gary Bogart, 14th edition, H. W. Wilson Co.
A basic bibliography of print materials for K-6.

Elementary School Library Collection, 14th edition, Bro Dart Foundation, 1984
A classified catalog of recommended print and audio-visual materials for library media centers serving pre-school through sixth grade.

Junior High School Library Catalog, H. W. Wilson Co.
Basic bibliography of print materials for grades 7-9

Senior High School Library Catalog, H. W. Wilson Co.
Basic bibliography of print materials for grades 9-12

The Book Report; The Journal for Junior and Senior High School Libraries
Publishes articles dealing with the theory and operation of secondary school libraries and reviews of books and other media.

Booklist
Purpose is to provide a current guide to materials worthy of consideration for purchase by small and medium-sized public libraries, school media centers, and community college libraries. A review in Booklist constitutes a recommendation for purchase.

School Library Journal
Publishes articles about all types of school library media centers. Has audiovisual reviews including computer software. Reviews books for K-12 and publishes various lists of best books. Publishes negative reviews.

PROFESSIONAL ASSOCIATIONS WHO PUBLISH BIBLIOGRAPHIES OF INTEREST TO SCIENCE TEACHERS

Agency for Instructional Television, Box A, Bloomington, Indiana 47402

American Association for the Advancement of Science, 1515 Massachusetts Avenue NW, Washington, DC 20005

International Reading Association, Public Information Office, 800 Barksdale Road, Box 8139, Newark, Delaware 19711

National Association for Childhood Education, 1834 Connecticut Avenue, NW, Washington, DC 20009

National Association of Independent Schools, 1800 Tremont Street, Boston, MA 02108

National Education Association, 1201 16th Street, NW, Washington, DC 20036

National Science Foundation, Washington, DC 20550

National Science Teachers' Association (an affiliate of AAAS), 1742 Conn. Ave., NW, Washington, DC 20009

National Wildlife Federation, 1412 10th Street, NW, Washington, DC 20036

BOOKS

Anderson, Ronald D., and others. *Developing Children's Thinking Through Science*. Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1970.

Furth, Hans G. *Piaget for Teachers*. Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1970.

Gega, Peter C. *Science in Elementary Education*. New York, London, and Sydney: John Wiley and Sons, Inc., 4th ed. 1982.

Ginsburg, Herbert, and Sylvia Opper. *Piaget's Theory of Intellectual Development*. Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1969.

Krathwohl, David R., Benjamin S. Bloom, and Bertram B. Masia. *Taxonomy of Educational Objectives: The Classification of Educational Goals*. New York: David McKay Company, Inc., 1964.

Renner, John W., Don G. Stafford, and William B. Ragan. *Teaching Science in the Elementary School*. 3rd ed. New York: Harper and Row, Publishing Company, 1979.

Sanders, Norris M. *Classroom Questions, What Kinds*. New York: Harper and Row, 1966.

READINGS IN JOURNALS

Joyce, Bruce, and Beverly Showers. "The Coaching of Teaching." *Educational Leadership*, XL (October 1982), 4-8, 10.

Goodlad, John I., "Where are School Goals Beyond the Basics?", *Educational Leadership*, XL (April 1983).

ARTICLES

Hallifield, John H., *"Education and High Technology,"* *Educational R & D Report*, VI (Fall 1983), 2-5.

JOURNAL ARTICLES

Karplus, Robert. "Part III Curriculum Project Reports: The Science Curriculum Improvement Study--Report to the Piaget Conference," *Journal of Research in Science Teaching*, January, 1964, pp. 236-240.

Kondo, Allan K. A Study of the Questioning Behavior of Teachers in the Science Curriculum Improvement Study Teaching the Unit on Material Objects. Doctor's dissertation, Columbia University, in M. B. Rowe (ed.), *Teaching Science as Continuous Inquiry*. New York: McGraw-Hill Book Company, 1973.

Newport, John F., and McNeill. "A Comparison of Teacher-Pupil Verbal Behavior Evoked by Science," *Journal of Research in Science Teaching*, III (1970), 191-195.

Piaget, Jean. "Development and Learning, Part I Cognitive Development in Children," *Journal of Research in Science Teaching*, II (September, 1964), 176-186.

Yager, Robert, "The Crisis in Biology Education," *The American Biology Teacher* (September 1982), 328-34.

Switzer, Thomas and Burton, Voss. "Integrating the Teaching of Science and Social Studies," School, Science and Mathematics, LXXXII (October 1982), 452-62.

IMPLEMENTATION SCHEDULE

To achieve the basic objectives within a given school and/or school district a series of major strategic actions have been recommended in the following implementation schedule

	Activity	Completion Date
1.	Select curriculum committee	_____
2.	Schedule time and budget for curriculum work	_____
3.	Discuss current problems and trends in education	_____
4.	Develop and/or review rationale for curriculum development	_____
5.	Review current state rules and regulations	_____
6.	Develop a philosophy for curriculum development	_____
7.	Review and modify curriculum objectives where needed	_____
8.	Get feedback from all staff and revise	_____
9.	Assess current programs	_____
10.	Decide on level of refinement and objectives to be adopted	_____
11.	Decide on level of revision required	_____
12.	Assess physical facilities and recommend changes	_____
13.	Match curriculum needs to textbooks and other curriculum material	_____
14.	Present curriculum materials under consideration to staff	_____
15.	Assess readability of materials under consideration	_____
16.	Visit other schools which are utilizing materials being considered	_____
17.	Pilot curriculum materials in select classrooms	_____
18.	Notify administration on materials to be selected	_____
19.	Provide teacher inservice of materials selected	_____
20.	Evaluate new curriculum	_____
21.	Assess student achievement	_____
22.	Arrange for regular curriculum review	_____

ATTITUDES

Curiosity - a desire to find out -- wanting to know

Concern/care - to express an interest in, protection for or series attention to all living and non-living things -- become important

Imagination - creating mental pictures of how things might be -- envision another way to do something

Honesty - a sincere expression of trustworthiness, fairness and justice

Self-confidence - sure and confident in one's own ability -- willingness to try new things and take risks with new ideas

Persistence - a determination to continue with an experience which can last for sometime -- refusing to give up.

CLASSROOM HINTS FOR THE TEACHER

Many of the activities used in teaching involve simple games, activity sheets for the students and simple objects that can be collected at a very low cost.

A PAPER SAVER

To save paper and allow students to practice, tape a long piece of plastic sheeting (like that used for winterizing a window) on a table. Use masking tape at each end and leave the sides free except at a few places. The students can use grease pencils to respond to practice sheets that are placed under the plastic. Whey they have finished and their work has been checked, the markings can be removed by wiping with a soft dry cloth. The practice sheets can be placed in a file for re-use --- saves time at the mimeograph machine.

USE YOUR PANTYHOSE CARDBOARD HOLDER

New pantyhose and other clothing items frequently have a cardboard holder placed inside them. Save these cardboard items for making objects used in games and activities which are homemade.

CLEAR CONTACT PAPER

Clear contact paper can be used to cover game cards or other activity cards which are made. Covering them with this clear film allows them to be wiped off where they were marked with a grease pencil. This allows the card to be used many times.

FILE FOLDERS

File folders on which games can be put can be covered with clear contact paper and used many, many times. Also, they are very easily stored.

ADDING MACHINE TAPE

Another idea is to use adding machine tape for students to do mathematics exercises, practice spelling words, etc. Cut a 1/4" dowel stick about six inches long. Put adding machine tape on dowel stick, then tape both ends of dowel to desk. As students need paper to practice on, they can just roll off as much as they need.

BABY FOOD JARS

For doing some activities, baby food jars can be used. To plant seeds, make small terrariums, aquariums, keep aged water in, etc. Also, zip lock bags are good to use for many activities.

This is just the beginning of classroom hints for teachers. New hints will be coming at various times during the school year. If you would like to add to the hints, please send your name to the Kansas Department of Education.

WHAT RESEARCH SAYS ABOUT "EDUCATING AMERICANS FOR THE 21st CENTURY

Science

The desired outcomes of science instruction involve understanding and appreciation of the external and internal biological and physical environments. Such learning must clearly be a lifelong process. Thus, there are many choices as to what topics are to be included from science and technology in elementary and secondary school education, whereas, in mathematics, there is a generally accepted sequence to provide essential building blocks.

The desired outcomes of science and technology involve various levels of rigor in topics and the stimulation of student interest to continue science and technology study throughout a lifetime. In the early years, students should have many opportunities to experience science in a real world (laboratory) context in a manner that does not separate the sciences into biological and physical science. The natural environment of the community and school can also be used as a laboratory setting. In the later years of high school, specialized courses will naturally be provided for those students especially motivated to pursue one or more of the science areas in greater depth.

Instruction in the sciences and technology in *grades K-5* should be designed to achieve the following outcomes:

- —Knowledge of phenomena in the natural environment and opportunities to use applicable arithmetic in the learning of science. In addition, the integration of science with the teaching of reading and writing should be actively pursued.
- —Growth in the natural curiosity of children about their physical and biological surroundings
- —Ability to recognize problems, develop procedures for addressing the problem, recognizing, evaluating and applying solutions to the problem.
- —Personal experiences with appropriate level hands-on science activities with both biological and physical phenomena.
- —Ability to use appropriate level mathematics in describing some science and in solving science problems.
- —Ability to communicate, orally and in writing, observations of and experiences with scientific phenomena.
- —Some knowledge of scientific and technical careers and of the necessary background for continued study in these areas.

Instruction for students in *grades 7 and 8* should place emphasis on the biological, chemical and physical aspects related to the personal needs of adolescents; and to the development of qualitative analytical skills. Instruction at this level should continue to build on students' earlier experiences and be designed to achieve the following outcomes through experimentation, text and community resources:

- —An understanding of how their own bodies function.
- —Recognition of societal issues related to science and technology.
- —Development of greater skill in observing, classifying, communicating, measuring, hypothesizing, inferring, designing investigations and experiments, collecting and analyzing data, drawing conclusions and making generalizations.
- —Growth in problem-solving and decisionmaking abilities.
- —Ability to ask questions, manipulate variables, make generalizations and refine concepts.
- —A beginning understanding of the integration of the natural sciences, social sciences and mathematics.
- —Familiarity with the usefulness of integrating technologies (calculator, computer, cable television) with experiences in the sciences.
- —Appreciation of local resources such as museums, scientists and specialists to extend learning experiences beyond the school walls and hours.
- —Continued development of a sense of a potential science role in career or life choices.

Secondary School Science

The number of topics covered in high school science courses would be drastically reduced. Attention should then be directed toward the integration of remaining facts, concepts and principles within each discipline and with other sciences and areas such as mathematics, technology and the social sciences. Ideas should be selected which can be developed honestly at a level comprehensible to high school students; developed out of experimental evidence that high school students can gather or, at least, understand and tie into other parts of the course so that their use can be reinforced by practice. In addition, all courses should provide opportunities to develop the ability to read science materials.

Biology

The primary need for the revitalization of biology education is the need for a conceptual framework that is more in harmony with understanding oneself and which is supportive of the national and global welfare.* The educational context of the biological sciences should be more sharply focused at different schooling levels. The curriculum in *grades K-6* should emphasize a study of nature and biological phenomena. In the life sciences of *grades 7-9*, the emphasis should be upon understanding oneself as a human being. General biology in the high school *(grade 10)* should emphasize biology in a social/ecological context.

Instruction should be designed to achieve the following outcomes:

—Understanding of biologically based personal or social problems and issues such as health, nutrition, environmental management, and human adaptation.
—Ability to resolve problems and issues in a biosocial context involving value or ethical considerations.
—Continued development of students' skills in making careful observations, collecting and analyzing data, thinking logically and critically, and in making quantitative and qualitative interpretations.
—Ability to identify sources of reliable information in biology that they may tap long after formal education has ended.
—Understanding of basic biological concepts and principles such as genetics, nutrition, evolution, reproduction of various life forms, structure/function, disease, diversity, integration of life systems, life cycles, and energetics.

Chemistry

At all levels, the social and human relevance of chemistry should be emphasized. The curriculum should incorporate a proper selection and integration of topics from both descriptive chemistry and theoretical chemistry.

Instruction should involve extensive hands-on experience and should be designed to achieve the following objectives:

—Illustration of how answers to chemical questions are obtained.
—Familiarity with the molecular description of matter and implications of such a particulate view.
—Understanding of elementary atomic structure and the regularities contained in the Periodic Table.
—Understanding of molecules and chemical bonds.
—Understanding of reactions (stoichiometry, equilibrium, energetics, rates).
—Familiarity with the chemistry of common substances (descriptive chemistry).
—Understanding of the states of matter, and the nature of solutions.
—Familiarity with applied chemistry (radioactive materials, common poisonous and combustible chemicals, water purification, prevention of food spoilage).
—Familiarity with the variety of chemistry-related careers.

Physics

An understanding of the basic principles of physics in a necessary foundation for most of the other sciences. The students' earlier exposure at the elementary level will have begun this understanding which is especially important for an understanding of many technological applications of science. Even for those students who do not go on to major in science or engineering, physics provides important examples of how the physical world works and the kind of answers scientists can (and cannot) give to the important questions of life. For this reason, courses must be designed for a wide variety of students.

Instruction should be designed to achieve the following objectives:

—Laboratory experiences including opportunities to acquire information inductively.
—Opportunities for continued development of more advanced mathematical techniques as applied to science matters.
—Comprehension of fundamental units, derived units and systems of measurement.
—Understanding of the concepts of motion from the smallest particle to celestial bodies.
—Understanding of the conservation of mass and momentum, of energy, the kinetic theory of gases and wave phenomena.
—Understanding of light and electromagnetism.
—Appreciation of atomic and nuclear physics, and of relativity.
—Familiarity with the variety of physics-related careers.

Approved 6/12/85

GOALS FOR FY 1986 KANSAS STATE BOARD OF EDUCATION

The following improvement and development goals are adopted from the *Five-Year Plan 1985-1990:*

The State Board and Department of Education will endeavor —

IMPROVEMENT GOALS

A 1.0 — To develop, strengthen, and extend state systems which support excellence in the curriculum and instruction programs of local education agencies

A 2.0 — To develop, strengthen, and extend excellence in vocational and career education programs and improve transitions within and among education and training systems and institutions

A 3.0 — To support and extend excellence in the preservice and inservice training of educational personnel

A 4.0 — To provide leadership in the use of information technologies for improving and extending educational programs

A 5.0 — To continue efforts to overcome barriers which limit the educational development of special populations not currently achieving their potential

A 6.0 — To work with school districts, state institutions, parents, and other citizens in extending support and financing for Kansas schools

DEVELOPMENT GOALS

B 1.0 — To identify the learning needs of populations not currently being served by schools and assess the feasibility of extended programs in local communities

B 2.0 — To improve and extend support for vocational and career education programs

B 3.0 — To conduct a study for developing a performance-based measure for the evaluation of teacher/administrator training programs and certification

B 4.0 — To demonstrate the use of information technologies by extending opportunities for networking and developing alternative learning systems

B 5.0 — To develop affirmative programs for overcoming past barriers for equal opportunity on the basis of race, sex, national origin, geographic location, age, socioeconomic status, or handicapping condition

B 6.0 — To identify methods of increasing resources for local schools and education programs

The following traditional goals were developed for FY 1986 to maintain the seven major functions of the State Board and Department of Education:

TRADITIONAL FUNCTION GOALS

Approval

C 1 — To promote quality education through program approval of teacher and administrator preparation programs and certification and accreditation procedures which reflect the needs of educators, school districts, and students

Regulation

C 2 — To set and require state guidelines, rules and regulations, and plans to achieve balance between constitutional and legislative intent and local policies, priorities, and procedures

Research and Service

C 3 — To provide services through the State Department of Education to local education agencies in the area of technical assistance, information, and resources

Evaluation

C 4 — To assess the progress of the educational system in Kansas

Leadership

C 5 — To provide leadership in identifying needs, priorities, and goals

Finance

C 6 — To support equitable finance plans that allow local education agencies to meet present and future educational needs

Organization

C 7 — To provide an organizational structure to ensure all students the opportunity to an equitable education